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PRESCRIBING LIGHT. AN IMPORTANT FACTOR IN THE CARE AND TREATMENT OF THE EYE*

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A strong incentive for our work in physiological optics has been to help prepare the way for a more extensive use of hygienic

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measures in the care and treatment of the eye. The subject of hygiene has been built up in the attempt to preserve and restore normality of function through regulation of the conditions under which the organ functions. In relation to the care of the organs of the body the growth of hygiene has been rapid. In relation to the sense organs, however, its progress, it would seem, has suffered retardation—perhaps undue retardation. Whether this situation is intrinsic or merely marks a stage in the development of the subject time alone can tell. In the case of the eye, at least, it would seem that hygiene can be made to play a much more important part than it does now, that is, that the care and treatment of the eye shall not be so narrowly dependent on the surgical measures, operation and the use of lenses and prisms.

Equally important with the formation of the image on the retina is its clear and comfortable discrimination. The provisions for this are the work of the science and art of lighting. In this work group and individual variations and needs must not be overlooked. These needs cannot be handled by regimentation. Clearly along these lines lie the most promising developments in hygienic lighting, developments which need the help and directive influence of the medical examiner.

Important Structural and Functional Considerations

In connection with the hygienic treatment of the eye we have to consider the muscular equipment of the eye, the structure and parts of the eye itself and the sensorium.

A notable feature of the visual mechanism is the delicacy and intricacy of its muscular equipment, and an important factor in the correctness of the visual performance is the normality of structure and function of this equipment. There are two aspects of hygienic treatment relating to this muscular equipment: (*a*) the correction of the gross and minor imbalances through either suitable exercises or other means as yet poorly defined and (*b*) the prevention of harm to the eye caused by malfunctioning of the muscles due to improper conditions of work. The influence of the grosser abnormalities on the accuracy of the combination of the images of the two eyes in binocular vision has received due recognition and study, but the influence of the lesser abnormalities on the clearness and correctness of the formation of these images has not perhaps been fully realised. One has only to remember how pliable the eye is to understand how readily it may be deformed by slight imbalances in the pressure exerted by the eye muscles in holding it in proper balance in any given position or in executing accurately the many movements it has to perform. When these pressures are excessive in amount or when there are

special conditions of weakness of the coats of the eye, permanent changes in structure may be produced, or the deformities may be present only *in situ*, that is, only when the eye is subjected to the pressure and pull of the muscles.

In respect to these deformities it will be remembered that deviation toward a prolate spheroid will cause myopia; deviation toward an oblate spheroid, hyperopia and irregularity in the deviation, astigmatism; also that only a slight deviation is required to produce a dioptre of defect and that deformities may occur either in the ball of the eye or in the cornea. In relation to the influence of muscular pressure on the shape of the eyeball, the following points should be considered: the attachment of the straight muscles by a broad insertion well in front of the centre of rotation of the eye and their passage around its curved surface to a point at the back and upper part of orbit; the passage of the two oblique muscles around the eye from their origin to their insertion in such a way as to give to some extent the effect of suspending the posterior half of the eye in a noose, and the possibilities presented for excessive pressure or unevenness of pressure in the action of these muscles.

In this connection it should be borne in mind that the muscles have the twofold function of supporting the eye and of moving it, and that it is in the relation or proportion of the forces which serve to support the eye that slight imbalances may be expected to occur. Slight disturbances in the relationship between the backward pull or tension of the rectus muscles and the opposing action of the oblique muscles, for example, may serve to change the length of the polar axis and otherwise deform the eye. Further, the correction of the imbalances in case of too strong a pull on the part of the converging muscles would require the action of the antagonistic muscles to prevent confusion of vision due to defective combination of the images of the two eyes, and this in turn might lead to an inequality of pressure which might serve to deform the ball of the eye or the cornea and thus tend to produce astigmatism, perhaps the customary astigmatism with the rule. Or again, in case of asymmetry in the pull or tension of these converging muscles this tendency toward torsion would have to be corrected by an opposing asymmetry in the tension of the antagonistic muscles. This composition of forces would tend to shift the direction of maximum pressure and produce oblique astigmatism.

It should further be remembered that these deformities as produced by the pressure of the muscles of the eye may be either congenital or acquired; perhaps they are most often acquired. It is, of course, in the cases in which the defect is acquired that there is the greatest possibility of success in the use of hygienic measures.

In relation to the pressures produced by the more customary movements of the eye and their tendency to cause elongation of the eyeball, it may be noted that the convergent movement considered from its beginning, in what is called the primary position, to its end, when the eye has made its maximum excursion inward, is a complicated function of three straight muscles, the internal, superior and inferior rectus muscles. The superior and inferior oblique muscles steady the eye during the excursion and perhaps aid the adduction in the more extreme positions of convergence. The diverging movement is also a complicated function of more than one muscle, the complication varying with the degree of abduction. In contracting, the converging muscles turn the front of the eye inward and press the eye against the external rectus muscle over a considerable portion of its length. The effect of the action of both sets of muscles, converging and diverging, is to exert a backward pressure on the contents of the eye toward the posterior pole, which backward pressure is opposed by the contraction of the oblique muscles. The point of attachment and the course of the oblique muscles, however, are such as to leave a segment of the back wall of the eye without external reinforcement. The front of the eye is reinforced by the pressure of the four straight muscles which are attached, as already indicated, on a broad base well toward the edge or limbus of the cornea and by the lens with its suspensory ligament. It is perhaps not too much to expect, then, that under the pressure of sustained convergence rendered excessive by bringing the work closer to the eye under poor lighting conditions and other faulty conditions of seeing, the coats of the eye, particularly if they are already weak from congenital or from degenerative causes, should yield in the region of the posterior pole.

In further relation to the harm done to the eye by the malfunctioning of its muscles as a result of poor conditions of work the situation with regard to the accommodation of the eye should not be left out of account.

In the attempt to understand the effects of poor lighting on the eye one of the most fundamental principles to keep in mind is that the eye is always under a reflex incentive to clear up vision. This incentive is so strong that it is extremely difficult to oppose it successfully by an act of will or voluntarily to make an adjustment detrimental to clear seeing. The eye has grown up under daylight. Under this condition only three adjustments have developed, and, indeed, only three are needed: the reaction of the pupil to regulate the amount of light entering the eye and to aid the lens in focusing the light from objects at different distances and accommodation and convergence to bring the object on the principal axis of the lens and the image on the fovea—conditions necessary

for the formation of the clearest images by the lens and for the best discrimination of these images by the retina. These adjustments take place under a sort of triple bond imposed by their common nerve supply, which is so strong that if one takes place the others also take place unless the power of separating them has been acquired, and even then their separation is accomplished only by great effort or strain. Artificial lighting, with its unnatural and unfavourable conditions for clear seeing, has come late in the history of the race, and the eye has not developed any reactions or adjustments to meet the conditions imposed. Yet the incentive to clear up seeing remains and leads to adjustments which, if allowed to take place, serve only further to blur rather than to clear up vision. For example, a change in accommodation, which is a change designed to clear up an image blurred by changing the distance of the object, is in no sense helpful but is only harmful for clearing up an image blurred by poor lighting conditions; yet so long as unclear seeing is present, due either to blurring of the image or to unfavourable conditions for its clear discrimination by the retina, the eye will strive by the three adjustments at its command to remedy the deficiency. This striving of the eye to clear up vision by ineffectual maladjustments is the cause of what is commonly called eyestrain and is an important cause of ocular discomfort. The misdirected effort or strain is of no service to vision and leads rapidly to fatigue and exhaustion, to deformities slight in their physical magnitude but great in their functional importance, to inflammations and congestions and to hypertensions and other conditions not found in a healthy eye. Accommodative strain in itself, for example, leads to hyperaemia or congestion of the network of blood vessels just in front of and behind the ciliary muscles. The congestion in this so-called danger zone of the eye leads in turn to an increased flow of fluid into the anterior chamber from the blood vessels on the anterior border of the ciliary muscles and into the vitreous chamber from those on the posterior border of these muscles and, perhaps, through the products of the congestion or inflammation, to a blocking up of the drainage angle between the iris and the base of the cornea. This tends to produce a disturbance in the normal balance of the income and outgo of fluids into the interior of the eye and the evils attending such a disturbance.

If the eye could only be educated to lie down under the poor conditions of seeing for which it has no specific corrective adjustment the cause of vision would be just as well or even better served, and the eye itself would be a great deal better off.

It is somewhat difficult to trace all the effects of eyestrain. It is not the result of a normal exercise of the powers of the eye in either kind or amount, and no possible benefit can accrue from

it. Rather it leads to an unhealthy condition of the eye, exaggerating and aggravating any abnormal tendencies or predispositions already present, lowering the normal recuperative and restorative powers of the eye and leading sympathetically to functional disturbances in other parts of the body. Like any other organ of the body, the eye if it is to remain healthy or to cure itself of any of its ills, congenital or acquired, must first be put into a situation calling only for the healthy exercise of its normal functions. Important factors in this situation are the conditions under which it is ordinarily called on to work.

Outstanding Features in Lighting in Relation to the Examination and Care of the Eye

The two important aspects of conditions of work as regards the eye are the type of work and its illumination. In relation to type of work the following points are to be considered in case the work involves the reading or discrimination of print on paper: reflecting power of the paper and type of reflection; colour of the paper; its texture and opacity; the blackness and flatness of the ink used; size of page or area of reading space exposed at any time; size, shape and spacing of print, etc. It is not, however, our purpose to do more than list these items here. In relation to the illumination of the work, we shall consider only four points in the present discussion: the intensity of the illumination, glare, the placement of the light and the colour of the light. We have selected these, first, because of their fundamental importance and, second, because we are completely equipped to provide hygienic conditions with respect to them.

Intensity of Illumination.—One of the most outstanding facts with reference to the intensity of the illumination is the wide variation that is found in the amount of light needed and preferred for different types of work, for persons of different ages and for different persons doing the same type of work and in the same age group. Important factors in these individual variations are: age, the refractive condition of the eyes, the health of the eye, the clearness of the media, the size of the pupil, susceptibility to glare and the keenness of discrimination of light and space. If too little light is used low visibility results, and the eye undergoes all the strain and malfunctioning of the muscular equipment discussed in the preceding chapters. In case too much light is used the excessively harmful effects of glare are experienced. For by far the greater number of persons the range of toleration of intensity for the comfortable use of the eyes is comparatively narrow for light of Mazda quality, and somewhere in this range is a pretty clearly defined preferred intensity. While the correct

adjustment of intensity is extremely important in case of all eyes, it is of paramount consideration in case of those eyes which come under the care of the ophthalmologist. It is not enough to say that they shall be used only for a certain number of hours a day. The conditions under which they can be used should be prescribed, and the prescription should be accompanied by the information needed to carry out the recommendations. In this way not only would the eyes in question be greatly benefited, but a much greater amount of work can be allowed.

There are two ways of dealing with the situation with regard to the regulation of intensity of light to individual needs. (1) The patient's range of toleration of intensity for the comfortable use of the eyes and his preferred intensity can be ascertained. On the basis of this information a prescription can be given him advising him what intensity he should have. For this purpose instruments of the type of our variable illuminator[1] can be very conveniently used. This procedure is not, however, completely satisfactory because of the difficulty the patient will have in filling the prescription with such lighting equipment as he is able to procure. In this connection it must be remembered that the preferred intensity must be closely approximated or the prescription will signally fail to accomplish its purpose; further that the exact amount of light needed varies with the kind of work, the time of day, variation in the condition of the eyes, etc. It is impossible satisfactorily to take account of all these factors in a single test period. Again, the patient may not even attempt to fill the prescription because of the trouble involved and the amount of technical knowledge and understanding it would entail. (2) A much more satisfactory procedure is to use the test only for the purpose of finding out approximately what is needed and then to recommend the use of a local lighting unit provided with an intensity control over the range which best satisfies the patient's requirement. He can then at any time and for any work adjust the intensity of light exactly to suit his needs. The purpose of the test in this procedure is that the examiner may find out the type of eye with which he is dealing for his own enlightenment in relation to the care of the eye, and that he may recommend the right type of lighting unit. To meet this need for a variable intensity, we have devised desk and table lamps, floor stand lamps, and bed reading and examining lamps provided with mechanical controls which change the intensity of the light in continuous series but do not change the colour or composition of the light nor the size, shape or location of the illuminated area.

It would be an ill-considered practice in lighting to make a blanket recommendation of a certain intensity of illumination or a narrow range of intensity for all persons, even for the same kind

of work. It will also be realised how difficult it is adequately to handle the problem of intensity by general illumination alone for any considerable number of workers. In some cases it is possible by means of information obtained by testing a group of workers so to distribute them in a room lighted by general illumination as to give some consideration to their individual needs. One example of where we have been able to accomplish this result with notable success was in a room in a large publishing house used by fifty or more proof-readers. In this case a systematic measurement was made of the intensity of illumination of the room, and each of the proof-readers was tested for the preferred intensity of light and then assigned to a location in the room that most nearly met the requirement. No significant change was made in the lighting of the room. The ideal way to handle the problem, however, would be to provide a suitable intensity of general illumination and use local lighting with variable control of intensity in individual cases.

Glare.—Glare is of two types, simple and veiling. Simple glare is a too high brightness in any part of the field of view due to excessive stimulation of the sensorium by light. In the centre of the field it is commonly called glare on the work; in the peripheral field it is usually due to the source of light, the lighting fixture, high reflections and poorly controlled or misplaced intensities of light. Glare on the working surface may also be of the type known as veiling glare. Veiling glare is an obscuring of the image on the retina produced either by an overlay of scattered light or by light reflected from the working surface which is not focused. The former is due to the diffusing or scattering properties of the lens and other media of the eye, and the latter to specular reflection from the working surface itself. In this latter respect it may be said that the light diffusely reflected from the working surface alone produces an image of that surface on the retina; the light specularly reflected would, if focused, produce an image of the source, not of the working surface. The eye in viewing the working surface naturally adjusts itself to focus the diffusely reflected light. This leaves the light specularly reflected unfocused. In proportion, therefore, as we have specular reflection, the image of the working surface is blurred and confused.

The experience of simple glare ranges from a feeling of too much light or an annoying brightness through the various stages of discomfort to acute pain. Veiling glare by producing confusion in the images causes eyestrain or discomfort through a misdirected and futile effort on the part of the muscles of the eye to clear up its images. That veiling glare causes eyestrain and discomfort is not difficult to understand. It is not so easy to explain the acute pain often caused by simple glare. This is perhaps due to a sharp contraction of the pupil, particularly if the

iris is inflamed or supersensitive, or to some condition or reaction set up in the eye itself or in the sensorium. In any event it is a warning or danger sign that harm is being done to the eye. In connection with the pain and discomfort experienced it will be remembered that the iris and other parts of the eye are richly supplied with pain nerves.

Eyes differ greatly in their susceptibility to glare. A study of this susceptibility and of the factors that cause it is an important need in relation to the care and welfare of the eye. It is especially important that susceptibility to glare and the requirements relating to intensity of light should be studied in case of diseases of the eye and of some of the more serious defects in refraction and other refractive errors that produce an irritable and supersensitive condition of the eye. We have, for example, observed the acute susceptibility to glare in cases of glaucoma, retinitis pigmentosa, iritis and conjunctivitis, high myopia, marked difference in the refractive condition of the two eyes and uncorrected or poorly corrected astigmatism.

In general the following subjective factors may be noted in connection with susceptibility to glare: age, size of pupil, condition of the media of the eye, health of the eye and general health, marked asymmetry of refraction of the two eyes, high myopia and refractive errors that produce an irritable and supersensitive condition of the eye, ocular and bodily fatigue, loss of sleep, insomnia, etc.; and the following objective factors may be noted as predisposing to glare: reflecting power of the surface viewed and character of the reflection (specular or diffuse), size of reflecting surface, intensity of light, angle at which the light falls on the work and breadth of angle of incident light, diffuseness of light, colour and composition of the light, high brightness in paracentral and peripheral field of view and their angular relation to the line of sight, etc.

The most acute problem in modern lighting from the standpoint both of hygiene of the eye and of the designing of lighting equipment has been, it scarcely need be pointed out, the elimination of glare.

Placement of Light and Brightness.—A third important feature in lighting is the correct placement of the light. This problem was created with the devising of lamp-shades for shielding the eye from glare and later giving these shades a reflecting lining to conserve and direct the light. When the opening of the reflector was turned down the light was directed towards the plane of work, and the walls and ceiling were left dark or poorly illuminated. On the other hand, when the opening of the reflector was turned up the light was directed to the ceiling and from there reflected to other parts of the room. This resulted in a disproportionately

high brightness of the ceiling and a correspondingly low intensity of light on the plane of work. Relief from the glare of the opening was obtained at the cost of poor and inefficient placement of the light. As a compromise between these extremes in the placement of the light recourse was had to inverted translucent bowls or housings which reflected part of the light to the ceiling and transmitted a part laterally and downward, to opaque housings or reflectors which directed part of the light upward and part downward (direct-indirect units) and to diffusing globes. While these units gave a better placement of light than either the totally direct or the totally indirect units the protection afforded against glare was far from adequate. In a later paper we shall show that the most favourable placement of light and brightness in respect to walls and ceiling is to have the maximum near the level of the eyes of the worker with an even and gradual decrease in both directions upward and downward, thus giving the upper part of the walls and ceilings for example, less than the maximum brightness. The next step in the development of lighting fixtures has been the use of baffles to give the minimum interference to the distribution of light from the source and the maximum protection against glare. This development has been discussed in former papers[2] and will be noted later in the present paper.

An important feature in the designing of equipment for both general and local lighting is the provision of a means for varying the placement of light to suit the needs of the particular situation. One of the difficulties in securing good lighting effects at present is the lack of flexibility and variety in this respect. The units that can be had ready-made of a stock or standard type differ widely in the lighting effects they produce. Thus it is somewhat difficult to adapt the units that are available to such situations as are presented by rooms of different sizes and shapes, of different ceiling heights, characteristics of walls and ceiling with respect to contour and surfacing, purposes for which the room is to be used, etc. This difficulty is sometimes met in what is called custom-made lighting by using units of special design and more than one type of unit in the lighting of the enclosure. A further possibility, as will be noted later in the paper, is to make provision in the unit itself for variability in the placement of the light. This can be done in both general and local lighting units, perhaps more easily and conveniently in the local units. It is possible, for example, in the designing of local lighting units practically to eliminate glare from the working surface without undue loss of luminous efficiency by suitable means for varying the direction and placement of the light on the work. A description of this means will be given in a later paper.

Colour and Composition of Light.—Among the reasons why

colour and composition of light are to be considered of importance in the care and welfare of the eye the following may be noted: (1) Coloured light gives the eye less power than colourless light to see objects themselves neutral as to colour. In former papers[3] we have shown this with light taken from the spectrum, with filter colours and coloured illuminants. The functions tested were visual acuity, speed of discrimination, power to sustain clear seeing and ocular fatigue. Black test objects on white backgrounds and the reading page were used as test material. In every case with colourless light, *i.e.*, colour-corrected light or light of daylight quality, the subject gave a better performance in all these respects than with coloured light. For spectrum light the best performance was given in the yellow (around wave-length 578 mu). On either side of yellow there was a decrease towards the long and short wave-length ends of the spectrum, the difference in performance varying with the function tested; that is, the decrease was greater for speed of discrimination than for visual acuity and greater for power to sustain than for speed of discrimination, as might be expected from the fact that the addition of speed and power to sustain adds sensitivity in any performance used as a test. In carrying out these tests the test surface for each colour was made of the same brightness and saturation. This equalisation as to saturation and brightness was also made in the tests with filter colours and coloured illuminants. An important factor in these differences of performance is that the sensation difference is greater for black on white than for black on any colour and greater for black on yellow than for black on any other colour. In this connection it will be remembered that the visibility of an object depends on its difference from the background as well as on its size.

(2) Colour and composition of light as well as intensity are factors in causing glare. This is apparently true for both simple glare and veiling glare. Glare occurs, for example, at lower intensities with artificial light than with daylight and light properly corrected for colour. And, again, it seems that coloured lights differ among themselves in their tendency to produce glare. Just why these differences should be present in case of simple glare it is somewhat difficult to understand. In case of veiling glare they are doubtless due to the difference in the tendency of the media of the eye to scatter lights of different wave-length and composition.

(3) There is a greater tendency for coloured light to produce ocular discomfort than for white light to do so. This tendency also differs among the colours themselves. This is found to be true both when the lights in question are used as illuminants and when the eye is exposed to them without any effort or attempt to discriminate detail.

The effect of colour on the eye's comfort and performance varies a great deal for different persons. Eyes made irritable and supersensitive by refractive defects and disease seem in general to suffer most from colour in light. It may be said, however, that daylight and artificial light properly corrected for colour are better for all eyes than coloured light.

Means for Improving Lighting Conditions

Current practice in lighting is characterised by high and harmful glare which is becoming worse as the level of intensity rises, and little means are being provided for adapting intensity and placement of light to the various needs and conditions that arise. From our point of view, adequate means of eliminating glare and varying intensity and placement of light as may be needed are three of four important points in good lighting. The fourth is feasibly commercial colour-correction.

Work on lighting in relation to the eye is not complete so long as it is confined to the study and investigation of principles and factors. Means must be found for applying what has been learned to the betterment of lighting conditions. After more than twenty years of study and experimentation in relation to factors and principles we have begun to try what we can do to improve lighting conditions, particularly with reference to intensity, glare and placement of light. We have, for example, devised means whereby any intensity of light that would be needed in both usual and unusual lighting situations can be secured with complete elmination of glare. This has been accomplished by the use of glare baffles or a plurality of non-reflecting light-shades of suitable size and shape so worked into the design of the fixture or housing of the source of light as to shield the eye completely from the glare of the lamp itself and all auxiliary reflecting surfaces and to give such wide and uniform distribution of light as to eliminate entirely all high and uneven brightness on walls and ceiling. These baffles have also been used to meet the requirements of local lighting. We have further included in local lighting the important feature of variable intensity of light, as has been noted earlier in the paper, and in both general and local lighting, that of variable placement of light; also provisions have been made for colour-correction when that is desired.

Our list of devices includes the following: inset ceiling and wall-bracket fixtures for commercial lighting and the lighting of hospitals, offices and homes; bed reading and examining lamps; desk and table lamps; floor stand reading and bridge lamps; lamps for the lighting of lecterns and speaker's desks; a device for lighting tunnels and corridors and for protection from glare

from automobile headlights; lamps for the optician's fitting table and the refractionist's chair, etc.

We have considered it worth while to note these devices here in order to show that it is possible to carry out the hygienic measures with reference to lighting that we have recommended for the care and treatment of the eye. Whether the means we have devised or some other shall be adopted is of secondary importance. The primary thing is to show that such results can be accomplished in ways that are entirely practical and commercially feasible. A too great obstacle to this end is encountered in relation to those who make and sell lighting equipment. The reasons for this are in part conventional but largely commercial. The changes from the traditional form of lighting requires the adoption of new ideas and new ways of thinking, also somewhat radical changes in manufacturing equipment. Further, the manufacturers of lighting equipment contend that there is no convincing public demand for better lighting. If and so far as this is true, there is need for competent and earnest educational service. In this respect the public naturally looks for guidance to physicians, in particular to the eye specialist. Our own experience, however, leads us to believe that the public is willing and eager to have better lighting if they knew what to get and where and how to get it.

The Examination of the Eye in Relation to Lighting

A complete programme for light prescribing should have the following features: (1) Tests should be made of the subject's preferred intensity of light and his range of toleration of intensity for the comfortable use of the eyes for the work he is most accustomed to do and for different kinds of work, of his susceptibility to glare and of his need for colour-correction. (2) From the results of the tests recommendations should be made as to the intensity of light he should use and the type of lighting equipment that will satisfy his needs in this respect and in respect to protection against glare and harmful colouration of light. With respect to glare, it may be said that while no eyes should be exposed to glare, more latitude can be allowed to some than to others. It is hoped and expected that in course of time the control of glare in public places at least will become a matter of public health and safety regulations.

All the aforementioned tests can be easily and conveniently made with an instrument we have called a variable illuminator. The purpose of this instrument is to provide a means of varying the intensity of the illumination in continuous change over a wide range, *i.e.*, from 0 to 100 foot-candles, without change in the colour or composition of the light or in the size, shape or position

of the illuminated area, and to provide a means of correcting artificial light to light of daylight quality. The essential features of the instrument are a source of light of adequate intensity to give the range needed, a housing of suitable size and shape, a mechanical means or specially designed shutter for varying the intensity of the light and a diffusing plate or other diffusing means both to eliminate completely shadows which would otherwise be produced by the shutter and to give an evenly distributed and well-diffused illumination of the test surface. The laboratory model of this instrument was described in a former paper[1] and mentioned in a still earlier paper[4]. It will suffice here to describe the means employed for varying the intensity, for diffusing the light and for giving the correction for colour.

The means of varying intensity consists of four vanes which extend across the opening of the housing in such relation to each other that when their flat surfaces are parallel to the beam of light the maximum amount of light passes through the opening, and when they are rotated to a position at right angles to the beam the light changes in continuous series from full intensity to zero. In changing the intensity the vanes are so actuated as to cause the contiguous vanes to turn in opposite directions. This insures absence of shift in the position of the illuminated area and absence of change in its size and shape. When the vanes all move in the same direction, as is the case with Venetian blinds, all these changes take place. In the various models of the instrument different means of actuating the vanes have been employed. For one of the models a simple means has been devised which lies within the housing and is entirely free from slack or backlash. This is in the form of a thin plate with a central longitudinal slot through which pass the axle pins at the ends of the vanes. This slot permits the plate to travel back and forth as the vanes turn. Above and below it in alternative sequence are short vertical slots which engage pins suitably positioned at the ends of the vanes. To the end of the axle of one of the vanes is attached a knob. When this knob is turned the contiguous vanes rotate in opposite directions as is desired.

The intensity of the light on the test surface for any position of the vanes can be read from a calibrated scale suitably positioned on the instrument. The spread of light from the opening has been checked at several distances to make sure that it follows the law of squares; thus, if a rating of the intensity is wanted at some other distance it can readily be computed from the reading on the scale. To secure constancy of current an ampmeter and rheostat may be used, if desired. Also the intensity of the light can be measured with a photometer, or light meter, instead of being read from the scale.

In order that no shadow shall be cast by the vanes in any position in their rotation a plate of Belgian flashed opal glass is mounted directly in front of them, between them and the surface to be illuminated. In addition to eliminating completely all shadows on the illuminated surface, the provision secures exceptionally good diffusion of light. For correction for colour, this diffusion plate may be slipped from its position in front of the vanes and the correcting filter inserted. Any colour filter that is desired may be used for this purpose.

The use of such vanes as we have employed in combination with a diffusing plate to eliminate shadows provides a simple mechanical means of varying the intensity of illumination over any range that may be desired and one that is free from the objections as to effects of illumination and inconvenience of use which may be noted in connection with other means of reducing intensity, such as change of distance of source, a rheostat, etc. Further, this means is readily and easily adaptable to many purposes, *e.g.*, lighting fixtures and equipment of various types, instruments supplied with special lighting devices, etc.

Test for the Preferred Intensity of Light.—In earlier papers we have shown the effect of intensity of light on such important functions as acuity and speed of vision[5], on acuity at different ages[6] and on the speed of vision at different ages[7]. In these papers it was shown in general how much the powers of the eye could be increased by increasing the intensity of light. However, in such determinations no account is taken of what intensity is preferred for different types of work or what range of intensity is favourable. That is, no account is taken of glare on the work as determining the upper limit, and of diminished acuity as determining the lower limit, of the amount of light that can be used with comfort. The difference between these two limits may be roughly called the range of the comfortable toleration of intensity of light. Intensities above the upper limit for comfort may be used in cases of emergency, for example to give higher visibilities when needed or a higher speed in the use of the eye; but they can hardly be recommended for ordinary uses of the eye or as best for it over long periods of time. In this connection it must be clearly and definitely remembered that visibility is only one of the factors that determine the amount of light that should be prescribed for the eye. Increase of visibility may still be present at intensities far greater than those at which the eye works most comfortably.

It is our purpose here to describe a test for the preferred intensity of light and for what we have called the range of the comfortable toleration of intensity. It seems reasonable to assume that the preferred intensity is the intensity at which the eye works most comfortably. No one could possibly know what this intensity

is except the person examined. The most transcendental egotist could hardly assume otherwise. In our earlier work on lighting, some twenty years ago, we objected to laying too much stress on preference as a criterion for the selection of the best lighting systems from the standpoint of the welfare and efficiency of the eye because such preference was apt to be influenced by too many other factors than those pertaining to the welfare and efficiency of the eye, such for example as aesthetic factors, architectural and decorative custom and habituation, etc. Further, in such cases it was not possible to present these lighting situations in sufficiently quick succession and with a sufficient control of other factors for a fair comparison to be made. In case of testing for the preferred intensity of light, these objections do not apply because aesthetic and other extraneous factors are not present to any harmful extent and the different intensities can be presented under properly controlled conditions at any rate of succession that may be desired. Also there is no possible way to know what is most comfortable to the person tested than through his own experience and report. If too little light is used his visibility will be too low for comfort, and if too much is used discomfort will be experienced because of glare or, it might be said, as a component of glare.

The test for the preferred intensity of light for reading may be selected to show in general how the test should be applied. Before making the test, the curtains should be drawn and the artificial light turned off. Because of the wide spread of light from the instrument (140 degrees) general illumination is not needed. The instrument provides a very favourable test condition in relation to the illumination of the surrounding field. That is, as the light on the reading page is increased there is a corresponding increase in the amount of light in the surrounding field. This avoids any tendency towards a spot-light effect as the intensity of illumination on the test surface is increased, and gives a type of illumination similar to that which would be obtained in a lighting system in which the increase of intensity is produced without an increase in glare. It should be remembered that there will be a low tolerance for the intensities of light that are needed for good seeing if the increase of intensity is accompanied by an increase in glare. In this connection it may be noted that with our variable illuminator and our glareless local and ceiling lighting units the test can be made and the prescription filled under the same conditions; namely, any intensity of light that may be desired in a practical lighting situation can be obtained without glare from the source.

In conducting a test of this kind no direct light from the instrument should fall on the patient's face to cause objectionable glare. Further, in case of those wearing glasses the light should never come from above or behind on either side, because of

harmful and annoying reflections from the rims and lenses of the glasses. In making the test with our variable illuminator, the patient is seated beside the instrument with his eyes back of the flaring bonnet or shield surrounding the opening of the housing. Thus no light falls directly on his face, and the light does not come from above or behind him. In order to give consistency and correctness of result and avoid the need of making a number of trials, the size of the pupil and the sensitivity of the retina should be standarised by exposing the eye for a suitable length of time to a properly selected intensity of illumination before beginning the test. The omission of this precaution is inexcusably bad technique.

Three sizes of type printed on test sheets of unglazed paper are used, one of the size ordinarily used in printing books (10 point), one of the size ordinarily used for magazines and newspapers (8 point) and one of the customary fine print used for footnotes (6 point). The examiner may use anything else about which the patient wishes information.

The patient should be seated directly in front of the test material at a comfortable reading distance and his eyes exposed for three minutes to the intensity of illumination on the test surface selected as standard for this purpose. Five foot-candles is suggested because it is judged to be fairly representative of the amount of light that is now being used by the persons who will be tested, the purpose of the test being to find out whether this is sufficient or how much more should be had. Moreover, we have found little difference in the result when the exposure was to 5, 10 and 20 foot-candles and in many cases no difference whatever when the test was made in accordance with the instructions given in the following paragraph, namely, when the series of intensities presented for the patient's judgment is given sufficiently slowly to allow the size of the pupil and the changing sensitivity of the retina adequately to keep pace with the changing amount of light. Except in cases where the eyes have previously been exposed for some time to very high or very low intensities of illumination we have found three minutes of exposure to be long enough to bring the eyes to a practically constant state of sensitivity to the illumination selected for the pre-exposure. In this connection it should be remembered that adaptation to light is much more rapid than adaptation to dark. That is, the eye when exposed to light loses sensitivity much faster than it recovers after exposure to light.

The full range of intensity of the instrument should be run to give the patient the experience of the different intensities. Then, beginning below 5 foot-candles, the intensity should be increased very slowly in order to give the size of the pupil and the changing sensitivity of the retina a chance adequately to keep pace with the

changing amount of light. The patient should be instructed to report when enough light is had for comfort in reading the test material. This intensity should be recorded and the increase continued very slowly, the patient being asked to report when the intensity is too great for comfort or is beginning to be glaring. The difference between these two points is roughly the favourable range, or the range of the comfortable toleration of intensity. The patient is next instructed to turn the knob on the intensity control and find for himself just what intensity he most prefers. He should be allowed all the time he desires to make this determination. Two results are thus obtained—the favourable range or range of toleration and the intensity most preferred. Both of these should be recorded on the prescription given the patient. The favourable range, it may be noted, is wider for daylight and for artificial light corrected for colour than for uncorrected Mazda light. It is, of course, wider also for eyes insensitive to glare. The tests for determining the amount of light needed for reading should be made for the three sizes of print in order of the largest to the smallest and then should be repeated for the largest size in order to minimise the effect of practice. If there is a difference in the result, the second value should be used.

In making a test of this kind the greatest danger that is incurred is that the examiner may force the results or prejudice the mind of the observer as to what results should be obtained and what prescription given as to the amount of light the patient should use. Correct prescriptions, if followed, will lead, on the whole, to the use of a great deal more light than is now being used, but the light will be distributed in accordance with actual needs. Results of studies made with this test will be given in later papers.

Tests for Susceptibility to Glare.—These tests have the following points of interest: (1) They sustain an important relation to the clinical examination of the eye. A test of simple glare is essentially a test for photophobia, made under better conditions and perhaps with a clearer understanding of the exact purpose of the test than it usually had when dealing with photophobia. It is not our purpose here to give a clinical evaluation of a test for photophobia, but it may not be out of place to point out that a diagnosis can rarely be made from the results of any one type of test alone and that it is entirely wrong to gauge the value of a test only or even predominantly by its possibilities in this direction. In the selection of tests for a diagnostic programme, for example, the important thing is not so much whether one test shows more than another as to whether it shows the same thing as that other. All diagnosticians will agree, we think, that competent diagnosis is based on as complete a picture of the condition as it is possible to obtain. Prejudice, inexperience or the lack of a just under-

standing alone could lead, it would seem, to any other conclusion. A test for veiling glare is a test for clearness or its converse, cloudiness of the media of the eye. Again, this sustains an important relation to more than one pathological condition of the eye and similarly should be considered as filling out the diagnostic picture. Further, quite aside from questions pertinent to diagnosis, any test which will serve as a sensitive means of detecting changes in the cloudiness of the media should form a valuable addition to the list of clinical tests. Inspection, it is scarcely needful to point out, is not adequate for this purpose.

(2) Tests for susceptibility to glare should have a place in a well-rounded and representative programme for the general examination of the eye. Like the physical examination in general medicine, such a programme sustains a broad relationship, the details of which need not be gone into here.

(3) Tests for susceptibility to glare have perhaps their greatest importance in relation to the care and treatment of the eye. While all eyes should be protected against glare, great care should be exercised in this respect in the case of eyes which show unusual susceptibility. As will be shown later, the variation in this susceptibility, even among eyes not classed as showing a pathological condition, is astonishingly great. In relation to tests, proportionately too much stress perhaps is put on their value in regard to diagnosis. Too often after the diagnosis is made one does not know what to do about the condition. In this connection tests which have for their purpose the determination of what is needed for the care and welfare of the eye in question obviously should not be overlooked.

The prime requisite for making a test for susceptibility to glare is to have a means of varying the intensity of light in continuous series over a sufficiently wide range without altering the colour or composition of the light or the size, shape or location of the illuminated area. For this purpose we have two instruments to recommend, our variable illuminator and our instrument for testing the light sense[8].

In the test for susceptibility to simple glare with the variable illuminator, the light may be thrown on a mat white surface of good reflecting power, such as Hering standard white paper, and of suitable size, such as the size of the reading page, this surface to be viewed at the reading distance when the test is made for susceptibility to glare in reading; or on a sheet of diffusing glassware positioned 5 or 6 inches in front of the opening of the illuminator. In the latter case the conditions of the test are the same with the exception that its glare is produced by transmitted light. In using the light sense instrument for the test, the glare surface is the illuminated field of the instrument. By means of

the iris diaphragm provided in the instrument for varying the size of the illuminated field, the glare surface may be adjusted to the size desired. In case a different shape of glare surface is desired, this can be obtained by throwing the iris diaphragm wide open and inserting in the slot provided for the purpose a stop or diaphragm of the shape desired. The test may be conducted in a dark room or, if that is not available, in a room from which all light excepting that coming from the test instrument is excluded as nearly as possible. In order to standardise the sensitivity of the eye, it should be exposed for three minutes to the test field illuminated at some suitable low brightness, which should be kept constant from test to test. The light in the test field should then be varied gradually from low toward high until the threshold of glare or uncomfortable brightness is reached, due precaution being taken with respect to factors that might influence the constancy of this result. Since size of pupil is an important factor in susceptibility to glare, an artificial pupil should be used in cases in which it is desired that this factor shall be ruled out. An artificial pupil is provided in the eyepiece of our instrument for testing the light sense. Means for this control are not provided with the variable illuminator. In case this instrument is used the artificial pupil may be worn in a trial frame, or our device for varying the size of the pupil described in an earlier paper[9] may be used. The latter device is admirable for the purpose.

In making the test for susceptibility to veiling glare also either the variable illuminator or the instrument for testing the light sense may be used. In case the variable illuminator is employed a detail of suitable size, shape and difference from the background may be impressed at the centre of the diffusing plate used as both background and surrounding field. The conditions with reference to amount of light in the room and pre-sensitisation or pre-exposure of the eye may be the same as those described in the test for simple glare. Again, the light is varied from low toward high until the detail at the centre of the field is completely obscured. Then the intensity should be varied below and above this point until the determination is made with certainty of the highest intensity at which the detail is still visible and the lowest intensity at which it disappears. The average of these two results should give a fairly correct and reproducible value of the threshold of veiling glare. In case the light sense instrument is used, the detail can be impressed at the centre of a plate of clear, colourless glass and this plate inserted in the slot provided in front of the field lens. The method of testing is then the same as that described with the variable illuminator.

No attempt should be made to compare the results obtained with the two instruments in testing for susceptibility to either simple

or veiling glare. Either instrument should give consistent results from time to time with the same person and comparable results for various persons and various places, but one instrument cannot be substituted for the other. In the latter connection it should be borne in mind with reference to the determination of susceptibility to simple glare that the test field in the two instruments is obtained in different ways. With the variable illuminator it is obtained by illuminating a diffusely reflecting or a diffusely transmitting surface, and this is viewed by the eye in the ordinary way; while in the light sense instrument it is obtained by focusing a collimated beam of light in the pupil of the eye by means of a lens, on the principle that when a parallel beam is focused in the pupil of the eye the lens is seen uniformly filled with light. In case of the test for susceptibility to veiling glare, not only this difference is to be considered but the fact that there is presented in the variable illuminator an initial amount of scatter of light due to the diffusing action of the test surface, while in the light sense instrument there is present only the scattering action of the media of the eye. Just how much this initial scatter by multiplying the number of angles at which the light enters the eye influences the scatter caused by the media of the eye and thereby perhaps influences the sensitivity of the test, cannot be told at this time.

In the test just described, it will be noted, the visibility of the detail to be discriminated is held constant and the intensity of the obscuring or glare-producing light is changed until the threshold of discrimination is obtained. It is obvious that the converse of this principle could also be used; namely, the intensity of the obscuring or glare-producing light could be kept constant and the visibility of the detail to be discriminated could be varied until the threshold of visibility was obtained. If the latter principle were used, our variable illuminator or some device provided with a shutter means of changing the intensity of illumination could be employed with convenience and advantage to vary the visibility of the detail.

The practical test, considered in relation to light prescribing, is a composite one which takes into account both simple and veiling glare. We refer to the determination of the upper limit of intensity for comfortable reading, which has been described under the heading " Test for the Preferred Intensity of Light." This test has the further advantage that it is made in the routine procedure of testing for preferred intensity of light. It will be understood of course that in non-pathological cases simple glare is the major factor in this determination.

We have studied with this test some 550 subjects with no pathological condition of the eye, ranging in age from 10 to 77 years.* A

* This study was made in collaboration with E. F. Lewis.

brief summary of the results obtained may be given here to show the wide range of variability that may be expected in susceptibility to glare in healthy eyes as measured by the upper limit of intensity for the comfortable reading of a page of ordinary type (10 point) and the importance of the need for testing for this susceptibility in relation to the care of the eye. An upper limit of intensity for comfortable reading of less than 5 ft-c. was found in 1·7 per cent. of the cases. This limit was between 5 and 10 ft-c. in 11·3 per cent., between 10 and 15 ft-c. in 26·5 per cent., between 15 and 20 ft-c. in 20·8 per cent., between 20 and 25 ft-c. in 11·2 per cent., between 25 and 30 ft-c. in 6·5 per cent., between 30 and 35 ft-c. in 4·7 per cent., between 35 and 40 ft-c. in 3·3 per cent., between 40 and 45 ft-c. in 2·2 per cent. and between 45 and 50 ft-c. in 3 per cent. The remaining 8·8 per cent. had upper limits of intensity for comfortable reading of between 50 and 100 ft-c. Thus it will be seen that for 13 per cent. the upper limit of intensity for comfortable reading was less than 10 ft-c.; for 14 per cent., above 40 ft-c.; for 73 per cent., between 10 and 40 ft-c.; for 65 per cent., between 10 and 30 ft-c.; for 58·5 per cent., between 10 and 25 ft-c.; and for 47·3 per cent., between 10 and 20 ft-c. From these data it might be considered that those who have an upper limit of less than 10 ft-c. are more than usually sensitive to glare and that those who have an upper limit of less than 5 ft-c. are extremely sensitive to glare, while those who have an upper limit of more than 30 or 40 ft-c. are less than normally sensitive to glare.

Test for the Need of Colour Correction.—The purpose of such tests is a determination of a condition which might be called chromophobia or chromasthenopia, that is, an unusual susceptibility to discomfort due to colour in light. In case of all eyes there is, so far as we know, a preference for light of daylight colour. Reasons for this are the greater comfort and efficiency that it gives, a lesser tendency to produce both simple and veiling glare and the higher visibility that is obtained for objects and backgrounds neutral as to colour, such as black objects on white backgrounds. There seems, however, to be no pressing reason for using the test unless the history of the case shows an undue amount of physiological aversion to artificial light, although many are more than willing to bear the expense of correction for colour for the sake of the additional comfort and benefit it gives. The particular need for it is acute in those cases in which there is a complaint of distress in working under artificial light. In such cases it should be used in conjunction with tests for the preferred intensity of light and susceptibility to glare in the endeavour to isolate the cause of the trouble. It would be well for the physician to take advantage of the information that can be had from these tests in all cases in which he is accustomed to prescribe entirely

or to limit the use of artificial light. In our own experience we have had a great deal of success in prescribing the use of colour-corrected light in cases of diseases of the eye and of troublesome refractive errors, or in cases in which there is undue nervous and ocular irritability.

Space might perhaps be allowed here for two examples. One is that of a distinguished research worker, scholar and teacher, around 70 years of age, the acknowledged leader in his field. This patient was entirely unable to work at night under ordinary conditions of lighting. So far as was known, there was in his case no pathological condition of the eyes and no unusual refractive defect. Under artificial light properly corrected for colour he was, according to his own statement, able to work if he chose until 2 or 3 a.m. His own version of the result was that colour-corrected light had saved his nights for him. The other case is that of a well-known editor and journalist about 60 years of age. This patient had lost the sight of one eye owing to disease, and the condition of the other eye was poor. He had been forbidden to work or read at all under artificial light. His testimony likewise was that colour-corrected light made it possible for him to work at night. So pleased was he with the result that he had colour-corrected light installed all through his house and was, the last time we talked with him, contemplating having it installed in his printing plant, stating that what has given him so great a benefit would, he thought, be good for his employees.

Complete correction for colour involves, it will be understood, a heavy loss of light. It is well, therefore, to be provided with filters giving different amounts of colour-correction in order to meet the requirements of different eyes and different lighting situations. Filters suggested are the daylight and whiterlite glasses furnished by the Macbeth Daylighting Company, etched to give the required amount of diffusion. The daylight glass used as a corrective of Mazda light gives a colour approximating that of an overcast sky. In the scale of colour temperatures this may be specified as around 6500° K. This colour temperature has been adopted by the U.S. Bureau of Standards as best for work with colour. The colour temperature of Mazda light filtered through the whiterlite filter may be specified as around 5500° K; that of Mazda light uncorrected ranges approximately between 2740° and 3000° K, depending on the wattage of the lamp used. Some benefit may be had by the use of the celestialite glassware furnished by the Gleason-Tiebout Glass Company. Filtered through this glass Mazda light is relieved of a great deal of the yellow quality that is so distressing to some eyes and to some extent objectionable to all eyes. This glass gives a high transmission of light which makes it feasible for use in all commercial

lighting. A further advantage is its high coefficient of diffusion. This glass may be added, if desired, to the test filters already recommended.

In selecting the colour filter great care should be taken that the filtered light obtained has a proportion of wave-lengths well balanced with respect to the welfare of the eye, such as is the case with the two types of glass supplied by the Macbeth Daylighting Company. Not every blue glass can be used to advantage as a filter for Mazda light. When spectrophotometered the blue bulb lamp of commerce, for example, shows an excess of light in the green. Also the glass used in making this lamp is not carefully standardised; that is, it is quite variable in its filter properties. Tests made by us for ocular fatigue and discomfort with this lamp gave a poorer result than that of tests made with unfiltered Mazda light.[10]

For one who really needs light-prescribing for colour, little more is required in the way of a test than to give him a chance to read or work under colour-corrected light. For him the benefit of colour correction is so great that there is no doubt as to the preference. However, if a more exacting test is wanted, the test for the preferred intensity of light and range of intensity for comfortable reading or working can be made both for corrected and uncorrected light. Thus the range of intensities used affords the observer ample opportunity to judge which gives the better results. Or the comparison can be made at equal intensities, for example at the preferred intensity for the uncorrected light or at some other representative intensity. The test should be made with all light as nearly as possible excluded from the room except that which comes from the test instrument.

In connection with the merits of colour-corrected light we may mention some results we have recently obtained with an instrument we devised in 1932 for the purpose of determining the amounts of light required to give equal visibilities for different kinds of light, different backgrounds on which the detail is to be discriminated, etc. We have called this instrument a Visibility Comparator. With it either the amount of light needed to give the threshold of visibility can be determined or the amount required to give equal visibilities at any level of intensity desired can be measured directly. The latter, of course, is the only procedure that can be relied on in the practical work of lighting. That is, the amounts of light required to give equal visibilities at any given higher level of intensity cannot be correctly determined by computation from the amounts required to give the thresholds of visibility. Measurements made with the instrument show in general that given visibilities in Mazda light can be equalled by the use of a much lower intensity of artificial daylight, the amount

of the difference varying for a given observer with such factors as the level of intensity used, size of print or other detail, etc. In the current practice of lighting the tendency has been to try to increase visibility by increasing intensity of light alone. In this a very serious difficulty is encountered in the glare and ocular discomfort that are apt to be caused by the use of these higher intensities. In case of many eyes this difficulty is very serious indeed and often in those cases where increase of visibility is most needed. In this connection the very great effectiveness of colour-corrected light for increasing visibility should not be overlooked. In fact, the best conditions for clear and comfortable seeing must include an optimum combination of intensity of light, colour of light and size of detail. We particularly feel the need of stressing the importance of the factor of correctness of colour. From the standpoint of the welfare of the eye there is everything to be said for this factor and nothing against it.

In case the examiner should want to test the preference of the patient with reference to any of the tinted lenses that are sometimes prescribed, either or both of the aforementioned procedures should serve this purpose very well. Particularly the test for the preferred intensity and the range of the comfortable toleration of intensity with both the tinted lens and the neutral lens should give as good an opportunity for making the comparison, as can readily be found in a test procedure. In the case of tinted lenses it should perhaps be expected that the benefit, when present, would be largely in terms of comfort rather than visibility. Quantitative tests for visibility are therefore apt to be disappointing. The test can be made, of course, with both artificial light and colour-corrected light. It would be expected, however, that the need for the test would be greater with artificial light.

In concluding this topic it may further be said that the eye has grown up under daylight illumination. It is only natural, therefore, that it should have an intolerance of an unbalanced spectrum or a dominant colour in illumination. This idiosyncrasy for colour seems to be present in all eyes. While, as already noted, it has been shown by test that yellow is the most favourable of all the spectrum colours with respect to ocular efficiency and comfort, still there is in all eyes a measure of intolerance even of yellow and yellowish light. Most people, however, are not aware of this at medium intensities. It becomes evident only at higher intensities and then in the form of glare. That is, with increase of intensity of Mazda light and other artificial illuminants giving light dominantly yellow, glare comes more quickly than with increase of intensity of daylight and colour-corrected light. With some eyes this idiosyncrasy with respect to composition of light is present at all intensities. These eyes get the discomfort without

the high brightness which characterises simple glare. They, therefore, need colour correction at all intensities.

The visual experience of simple glare might perhaps be analysed into high brightness, dazzle and discomfort. Dazzle might be described as an unclearness of visual detail due, it may be, to a confluence of excitation or what has been called irradiation—this confluence or irradiation becoming noticeable and annoying only at the higher intensities of light. In other words, details may be confused or blotted out under high intensities of light by a scatter of excitation in the sensorium as well as by a scatter of light by the media of the eye. Veiling glare should in all probability be regarded as a combination of both of these actions.

Intensity of Light and Strength of Reading Glasses

In any series of tests for the prescribing of intensity of light it will be found that the major need for individual testing is for the adolescent, the sick and defective, and for the presbyopic and near-presbyopic eye. There is much less need for individual testing of normal eyes between the ages of 20 and 35 years. We have found that the greater number of these eyes prefer a medium intensity over a comparatively small range. In case of the presbyopic eye the greatest benefit from the test may be had for eyes in the early and midde stages of presbyopia. These comments are based on the results of the study of eyes of different ages noted earlier in the paper.

There are two means of aiding the presbyopic eye to see an object at the desired near distance, namely, a correcting glass and intensity of light. The former of these is the major aid and the latter a minor or auxiliary aid. However, the proper selection of either cannot be had without reference to the other. The preferred procedure is the selection of the optimum combination of intensity of light and strength of glass.

So far as the correcting glass is concerned, it may be said that the strength of glass required at a given near distance sustains, within comparatively narrow but significant limits, an inverse relation to the intensity of light used. At high intensities the work can be discriminated with a weaker glass than at medium and low intensities. This is due for the greater part, if not entirely, to the effect of the higher intensities of light on acuity and the visibility of the object. At medium and low intensities stronger glasses are needed. Through this range, however, there is less effect of change of intensity on the preferred strength of glass—little, in fact, until very low illuminations are reached. At these intensities the tendency is to choose a still stronger glass in order to secure a benefit from magnification. This glass, however, would not in most cases be satisfactory at medium and high

intensities without changing the distance of the work, and probably not even then, because of the greater amount of convergence required, the less favourable relation between accommodation and convergence, and the undue limitation of the range of distance over which the object can be discriminated. At these intensities the additional magnification is not needed for the comfortable discrimination of the object.

It cannot be too strongly urged that due attention be given to both intensity of light and strength of glass in prescribing the conditions of seeing for the presbyopic eye. Often too strong glasses are prescribed because too low an intensity of light has been used in making the examination; and, conversely, frequently too high an intensity of light is advised or required because the person is wearing too weak a glass, in which case he may be compelled for the sake of adequate visibility to work at intensities above his threshold of glare. A fuller discussion of this topic with illustrative data has been given in a previous paper in this Journal.[11]

Summary

In comparison with other branches of medicine the development and use of hygienic measures in the care and treatment of the eye seem to have suffered retardation, perhaps unduly so. The subject of hygiene has been built up in the attempt to preserve and restore normality of function through the regulation of the conditions under which the organ functions. Like any other organ of the body, the eye, if it is to remain healthy or to cure itself of any of its ills, congenital or acquired, must first be put into a situation calling only for the healthy exercise of its normal functions. Important factors in this situation are the conditions under which it is ordinarily called on to work, two important aspects of which are the type of work and its illumination. Of these aspects the latter is the more amenable to variation and control. Radical changes cannot be made in the work itself, although some improvement in this direction may come with time. Obviously the lighting of the work is the more promising and the more important angle of attack.

For more than twenty years we have studied lighting in relation to the eye. The results obtained and the principles discovered, however, belong essentially to the general subject of lighting. They are not sufficiently specific to be of direct and significant service to the physician. For him the subject of lighting narrows down primarily to what is needed for the individual patient who comes under his care. For the determination of this, special tests which can be easily and conveniently made are needed. The next step is to see that what is needed can be obtained; in short, the

prescription must be filled. In later years we have devoted a great deal of our work in lighting to those ends. Means and methods of testing have been devised which cover the more important aspects of lighting, and with them we have studied the characteristics and variability of individual needs in both non-pathological and pathological cases. Lighting equipment of sufficient range and flexibility has also been devised, and a great deal of time has been spent in making it available to the public. Thus a new division of the subject of lighting has been created which belongs in its narrower and more technical aspects to the medical profession and in its broader and more general aspects to the welfare and personnel worker. The prescribing of light to meet the requirements of the individual person has become a practical possibility, and we strongly believe that when properly used it will be of significant service in the care and treatment of the eye. The need for it is acute in many of the cases which come under the physician's care.

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APLASIA OF THE OPTIC NERVES

BY

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THE following is an account of a rare condition seen in Mr. Rupert Scott's clinic at the Royal London Ophthalmic Hospital.

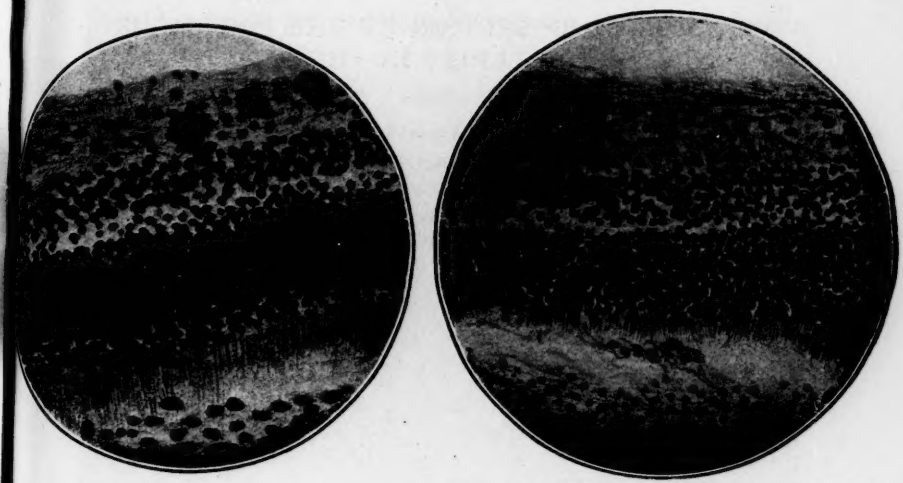
T.V., aged one year, an only child, was brought by his mother, who suspected blindness. There was no history of any ocular defect in either the paternal or maternal families. The mother stated that the child did not appear to follow light, but that she thought it possible that he was conscious of bright sunlight.

On examination, the child did not follow light at all. The anterior portions of the eyes were quite normal. There was no nystagmus. The pupils were inactive to light but varied in size from time to time, apparently irrespective of stimulus. The media were clear. The fundi presented the peculiar appearance shown in the drawing. The red reflex was pale, especially at the periphery, and the choroidal pattern very well marked. In place of a normal optic disc was a deep excavation, the base of which appeared to focus about 5 dioptres beyond the general retinal level. The colour was grey. From the base of the pit emerged only minute threads representing retinal vessels, the lower branch in the right eye being the only one which contained more than a trace of blood, and even this appeared to fade out soon after leaving the edge of the excavation.

Cases of complete or even partial aplasia of the optic nerve are very rare, and very few are on record. They are nearly always accompanied by severe deformity, such as anencephaly, hydrocephalus (Rosenbaum), or at least mental defect (Zeeman and Tumbelaka). The majority of cases in the literature are those with approximately normal retinal vessels, but with the optic disc either very small (Velhagen), or even absent (Briere, Hawley, Schwarz).

A fundus drawing of the case described.

The only case discovered resembling the one described is that of Szymanski, which occurred in a cat. The case was discovered quite accidentally and one eye only was abnormal. The optic disc was represented by a cavity from which emerged only strand-like vessels containing very little blood. It was fortunate that the



Normal cat's retina. Abnormal retina showing absence of ganglion cells.

Microscopical sections of retina of Szymanski's cat.

abnormality occurred in a lower animal, as it permitted excision of the eye and microscopical examination. This showed complete absence of the ganglion cell and nerve fibre layers of the retina, though the external layers were present. It seems highly probable that a similar condition would be discovered if section of these human eyes were possible.

My thanks are due to the Staff at Moorfields, and in particular to Mr. Rupert Scott and Miss Ida Mann for their help and their permission to publish this case.

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THE EFFECT OF SECTION OF THE POSTERIOR CILIARY ARTERIES IN THE RABBIT

BY

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Introduction

OVER 45 years have passed since Wagenmann (1890) carried out his classical experiments on rabbits, in which he produced a pigmented degeneration of the retina by section of the posterior ciliary arteries. His observations were repeated and confirmed by Krückmann (1899) on rabbits, and by Capauner (1893) on frogs and rabbits. Nevertheless, it seemed that it might be advisable to repeat his experiments and re-evaluate his results in the light of present day knowledge, and especially so because of the controversy that has existed for many years on the question of the pathogenesis of retinitis pigmentosa. Gonin (1902), Nettleship (1903), Greeves (1912) and others, have all suggested that a choroidal vascular disturbance must be the underlying cause and Wagenmann's experiments have figured largely in the arguments which have been advanced in favour of this view. In 1919 Treacher Collins put forward another theory. He suggested that there was some inherent weakness of the rods and cones that caused them to die. He adopted the term " abiotrophy " to describe his idea of the underlying process. The vascular theory has also been opposed by Verhoeff (1931). Lately further evidence supporting Collins' idea has emerged from the work of Bourne, Campbell and Tansley (1938) on familial degeneration of the retina in rats. The findings of these latter workers indicate that there is no choroidal vascular lesion.

In the present experiments the technique described by Wagenmann was followed as closely as possible. In this, certain difficulties arose that make it necessary to qualify certain of Wagenmann's statements. Preliminary anatomical studies of the distribution of the posterior ciliary arteries in rabbits showed their close relationship with the ciliary nerves. The arteries and nerves are so intimately entangled, corkscrewing about each other, that it is impossible to cut, tear or twist the arteries without injuring the nerves. Wagenmann also stated that interference with only a few posterior ciliary arteries was enough to produce retinal degeneration in the area supplied. The results of the

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present series of experiments indicate that a much greater interference is necessary.

Methods

Young adult rabbits were used, which were for the most part pigmented. Nembutal was the anaesthetic employed with the occasional addition of a little ether. The nembutal was given intraperitoneally in doses of 5 grams per kilo. of body weight.

The retrobulbar structures were exposed by section of the superior rectus muscle at its insertion and by rotation of the eye downwards. A poorer, though adequate, exposure can be obtained by section of the inferior rectus muscle and rotation of the eye upwards. This is so because the optic nerve enters the globe somewhat above its posterior geometric centre. In these experiments the approach from above was used most frequently. The ciliary arteries and nerves enter the eye about the optic nerve, but their main bulk lies slightly below and to each side of it. Some difficulty was encountered from the hæmorrhage occurring immediately on cutting the arteries, which tended to obliterate all fine structures. This difficulty was largely overcome by carefully localising all structures before cutting the arteries. The inferior or superior rectus muscle, as the case might be, was then sutured in place and the conjunctival wound was closed. By preserving aseptic surgical technique throughout, the wound rapidly healed with no untoward effects.

Altogether twenty eyes were operated upon. They were removed at intervals of 3, 4, 7, 10, 17, 30 and 126 days after operation. This was carried out under anæsthesia and the eyes were immediately placed in Zenker's solution. After dehydration and clearing they were embedded in paraffin. Sections were cut 8μ thick. Haematoxylin and eosin were used generally for staining, but both Feulgen's nuclear stain and Mallory's phosphotungstic acid haematoxylin stain were used to show finer details.

Actual counts were made of the number of rods and cones in the degenerated areas and in the corresponding normal areas in an attempt to determine their relative rates of degeneration.

Results

One of three results occurred after section of the posterior ciliary arteries, depending on the number of vessels cut. There might be no changes, complete phthisis bulbi, or a localised area of retinal degeneration in the region supplied by the bulk of the vessels sectioned. In order to produce an area of degeneration it was found necessary to interfere with at least two thirds of all the posterior ciliary arteries. Even then the results were uncertain.

Nothing at all might occur or there might be phthisis bulbi. It seemed that the collateral circulation of the choroid was so good, that it was very difficult to interfere with just enough vessels and not too many. These results do not confirm the statement of Wagenmann that section of only a few ciliary arteries was necessary. They are in keeping, however, with the present day knowledge of the vast and ramifying interconnections of the choroidal vessels. Subject to these qualifications the present findings support those of Wagenmann.

Of the three possible results of section of the posterior ciliary arteries those cases where there were areas of local degeneration of the retina mainly concern us. In these cases the first change to be noticed ophthalmoscopically was an area of extreme pallor coming on immediately after operation. The retinal vessels always appeared normal in calibre. The pale area spread roughly fanwise from the optic nerve head out to the ora serrata. Within a very few hours this area became somewhat less pale and definitely swollen with less sharply outlined edges, indicating an oedematous process. In about a week this picture gradually changed. As the circulation was restored in certain areas the normal appearance returned. In others where the circulation was

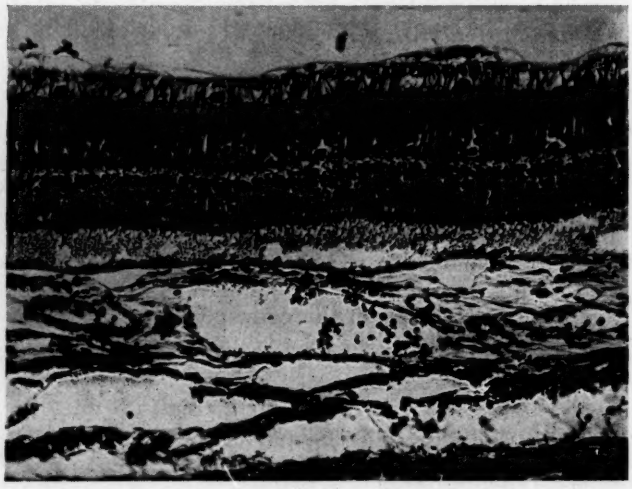

FIG. 1.

Section which shows the normal retina and choroid in a moderately pigmented rabbit. Zenker: Haematoxylin and Eosin. × 10.

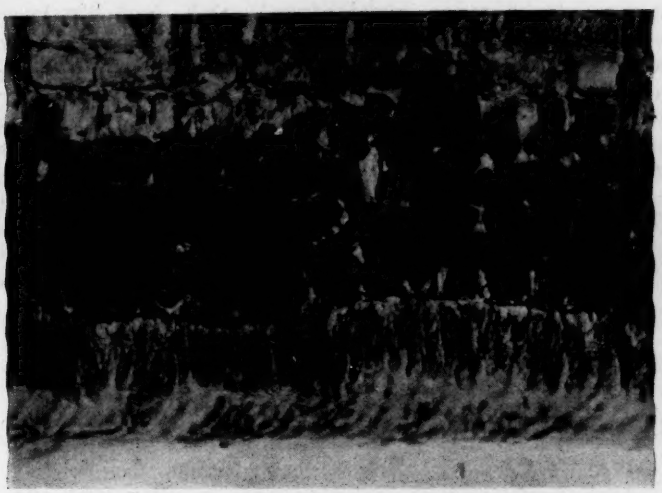

FIG. 2.

Section which shows the details of the outer nuclear, and the rod and cone layers in a normal rabbit retina. Note the cone nucleus in the centre of the field lying upon the external limiting membrane. Zenker: Haematoxylin and Eosin. ×940.

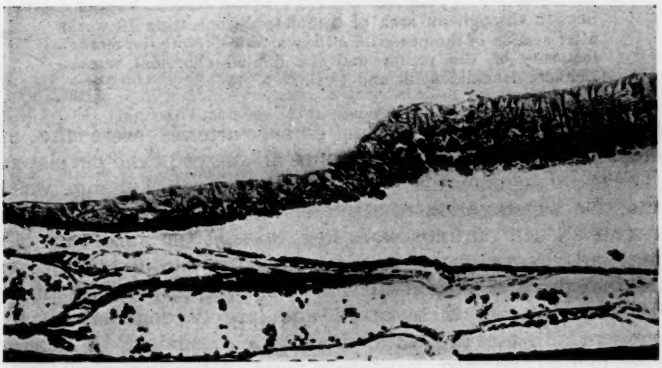

FIG. 3.

Section through the border of an area of retinal degeneration 17 days after section of the posterior ciliary arteries. Note the marked degeneration starting with the outer nuclear and rod and cone layers, and the dilated choroidal vessels. Zenker: Haematoxylin and Eosin. ×110.

not restored the retina remained pale and gradually became spotted here and there with round sharply circumscribed dense accumulations of pigment. These latter areas were seen to be grouped for the most part in the region of the equator. At no time or place was the pigment seen to have any relation to the retinal vessels. The changes progressed over several weeks and reached a stabilised state in about four or five months. Contraction of the degenerated areas finally took place and threw the normal areas into shallow folds.

The histological changes in the retina were in exact agreement with the ophthalmoscopic findings. The changes seen two weeks

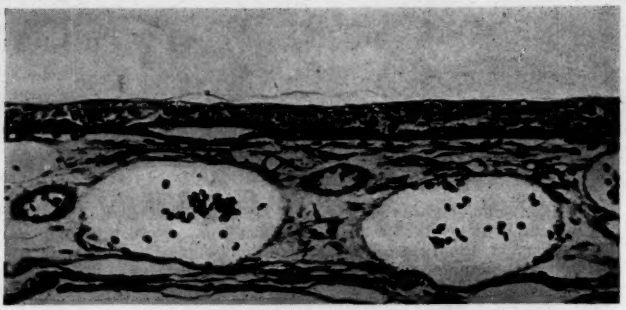

FIG. 4.

Section through an area of complete degeneration 19 weeks after section of the posterior ciliary arteries. Note the marked tenuosity of the retina and the dilated choroidal vessels. Zenker: Haematoxylin and Eosin. ×210.

after section of the posterior ciliary arteries were the most interesting since they showed at once all stages in the development of the retinal degeneration (Fig. 3). The essential change was one of massive degeneration of all layers of the retina. This became thin and all cell outlines were lost, so that the substance of the retina had a somewhat homogeneous granular appearance with here and there a degenerate nucleus (Fig. 4). The pigment epithelium beneath these areas was largely degenerate and in places entirely absent, while the pigment, mainly in rod form, tended to migrate into the deeper parts of the degenerate retina, where for the most part it was contained in large round cells. Considerable quantities, however, could be seen free and in clumps. At the borders of the areas of complete degeneration the retina showed gradual thinning of the rods and cones and outer nuclear layers, and, in places, oedema of the outer reticular

layer. The signs of degeneration of the rods and cones were first crumpling and fragmentation of the outer limbs, secondly of the inner limbs, and finally, the nuclei became pyknotic. In general the nuclei showed an extraordinary resistance to the degenerative process (Fig. 5). The pigment epithelium beneath these border areas showed little or no change unless the external limiting

FIG. 5.

Section through the border of an area of degeneration 17 days after section of the posterior ciliary arteries, which shows the very thin outer nuclear layer and the much degenerated rod and cone layer. In spite of this the rod nuclei present are well preserved. Note the degeneration of the pigment epithelial layer in the centre of the field. Just above this the external limiting membrane is defective. Here the pigment has begun to migrate. Zenker: Haematoxylin and Eosin. ×940.

membrane was involved, when migration of pigment took place and the pigment epithelium became attached to the retina rather than to the choroid (Fig. 6). This is in agreement with the findings of Treacher Collins, who believed that the pigment migrated through gaps in the external limiting membrane left by the degenerated rods and cones. Where there was marked destruction of the outer nuclear and the rod and cone layers, glial and fibrous tissue replaced the loss. Also scattered polymorphonuclear leucocytes could be seen in these areas (Fig. 7).

The process is thus seen to be a pigmented degeneration of the

retina starting in the deeper layers and finally spreading throughout the retina. The histological changes in an eye removed five months after section of the posterior ciliary arteries supported this view. By this time the process had become stabilised. Normal retina abutted more sharply on areas of complete

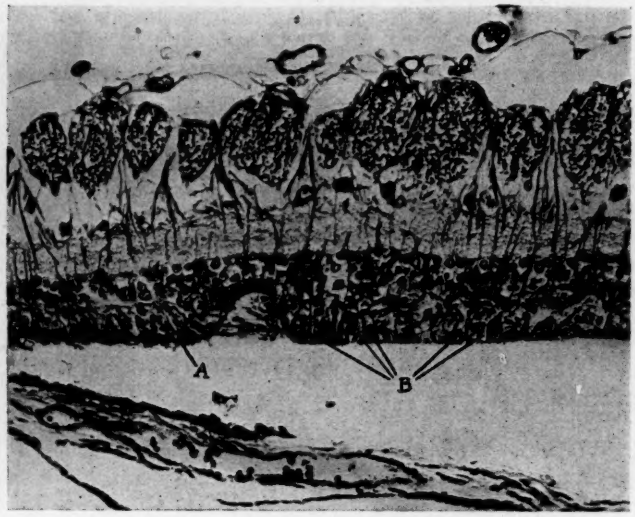

FIG. 6.

Section through the border of an area of retinal degeneration in a rabbit 17 days after section of the posterior ciliary arteries which shows the migration of pigment. On the surface of the retina can be seen bundles of myelinated nerve fibres, which in the rabbit extend horizontally on each side of the optic nerve head.
A. External limiting membrane.
B. Pigment in clumps.
Note that the pigment epithelium is degenerate and the pigment has migrated only where the external limiting membrane has disappeared. Zenker: Haematoxylin and Eosin. ×210.

degeneration. In the latter the retina was remarkably thin, showing a mixture of ill-defined cell remnants and glial tissue. In the deeper parts there were numerous large round cells stuffed with pigment, which tended to group together. Where this grouping took place there was also much extracellular pigment, free and in clumps. This accounts for the ophthalmoscopic picture seen at this stage. The pigment epithelium beneath these areas was degenerate and irregularly swollen and in some places

absent. On the borders of these regions, there was a rapid thinning of the outer nuclear layer, while little organisation, and no oedema of the outer reticular layer could be seen. Close to the area of complete degeneration the outer reticular layer was frequently found to be collapsed, so that the remaining nuclei of

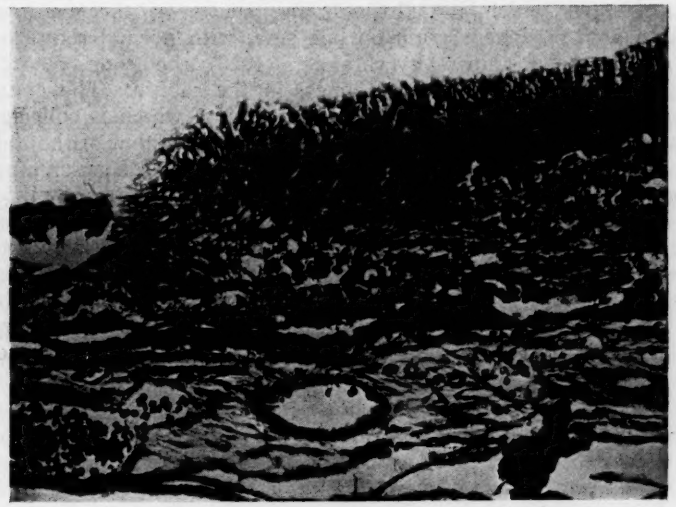

FIG. 7.

Section through the border of an area of retinal degeneration 17 days after section of the posterior ciliary arteries, which shows glial tissue replacing the loss of tissue. Note the group of polymorphonuclear leucocytes in the retina at the extreme right. Zenker: Haematoxylin and Eosin. ×210.

the outer nuclear layer and those of the inner nuclear layer intermingled.

The changes in the choroid were interesting but not very marked. The sections showed that the vessels were dilated and contained a good deal of blood, indicating a stagnation of blood rather than an hyperaemia. Here and there the choroid was thinner than normal, the vessels being smaller and empty. The existence of either picture seemed to bear little uniform relationship to the degree of retinal degeneration. Even under normal conditions there are great variations in the vascularity of different parts of the same choroid. It would seem that the choroid is normally under a continually varying neuro-vascular control and

that after an operation of this nature the process was apparently exaggerated.

Actual counts were made of the rods and cones to determine if possible the relative rates of their degeneration. The counts were made on an eye removed nineteen weeks after section of the posterior ciliary arteries. This stage of degeneration was chosen because the picture had become stabilised at that time. A section was selected which ran through the centre of the eye and had an area of degeneration on one side, with normal retina on the other. As shown by Menner (1929) the rods can be distinguished easily from the cones, in the rabbit. The cones have an egg-shaped nucleus, the chromatin of which is collected in a network of threads. It is slightly larger than that of the rod, the chromatin of which is collected in two or three dense clumps, separated by a clear non-staining area (Fig. 2). The cone nuclei are situated near or right above the external limiting membrane while the rod nuclei are situated farther away and arranged roughly in columns. Menner remarks on the difficulty of distinguishing between the processes of the rods and cones in the rabbit. The present author found that the outer limb of the cone tends to be a little shorter than that of the rod, while the inner

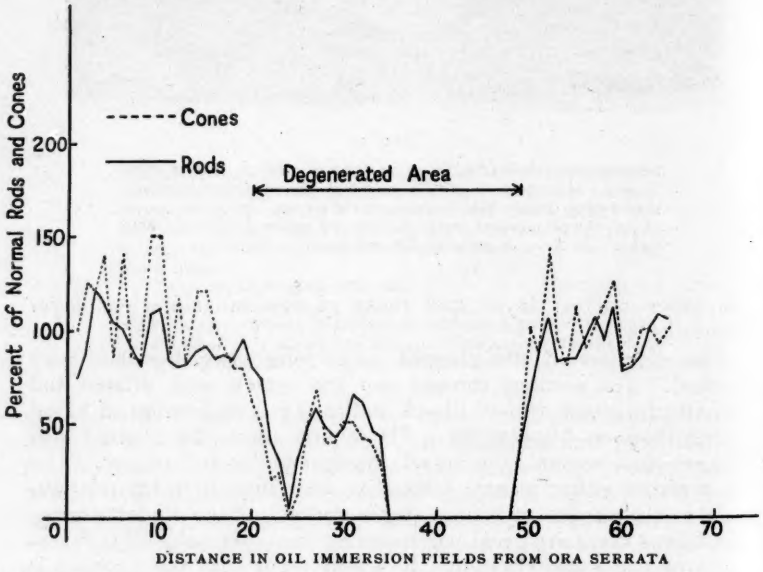

FIG. 8.

limb is slightly broader particularly at its upper end, in which the nucleus is situated. The differences were so slight, however, that the two could most easily be distinguished by the difference in their nuclei.

As the degeneration produced by interference with the posterior ciliary arteries affected the nuclei last of all, quite accurate comparisons could be made by counting the number of rod and cone nuclei that could be distinguished as such in each oil immersion field. As only the relative number of rods and cones in any one particular area was of interest, slight variations in the thickness of the section could be ignored. In Table I the rod and cone counts have been tabulated, the counts on the degenerated side being placed alongside those of the corresponding area on the normal side. Each count has been numbered in the table as so many oil immersion fields from the ora serrata. The diameter of one oil immersion field was calibrated and found to measure 0·175 mm. The ora serrata in the rabbit is 2·0 mm. from the limbus, so by means of simple calculation the exact topographical location of each count can be determined. In Figure 8 the results have been presented in another way; the percentage change in the rod and cone counts on the degenerated side have been plotted against the distance in oil immersion fields from the ora serrata, taking the respective counts on the normal side as 100 per cent. The graph shows that the rods and cones degenerate equally rapidly. These results were checked and confirmed by other and less exhaustive counts on different eyes.

Discussion

The histological changes described by Wagenmann are exactly similar to those found in the present experiments. That they are the result of a purely vascular disturbance must, however, be accepted with some reservations, which though probably unimportant are none the less real. As stated above it is impossible to interfere with the posterior ciliary arteries without injuring the ciliary nerves, because of their intimate anatomical relations to one another. In evaluating the results of such a procedure one must keep in mind the possible trophic or neuro-vascular functions of these nerves. In point of fact the possibility of neuro-vascular functions need not cause us concern as the whole purpose of this form of operation is to produce a vascular lesion. But the possibility of pure trophic functions must be kept in mind. In this connection, however, it should be remembered that not only is there no evidence that the ciliary nerves have any pure trophic functions, but that there is much negative evidence

indicating that no such functions exist. In the present series of experiments the first signs of degeneration were seen in the cytoplasm of the rods and cones, while pure trophic disturbances are usually indicated by a degeneration appearing first in the cell nucleus. In serial sections through eyes in which only a few posterior ciliary arteries, and of course, ciliary nerves, had been cut, not the slightest evidence of retinal degeneration was ever found. If the ciliary nerves had any pure trophic functions, there should be some evidence of it in such sections. Further, Capauner's results on frogs, in which he cut the ophthalmic artery, presumably without injuring the ciliary nerves, indicates that Wagenmann's and the present results can be accounted for by a purely vascular disturbance.

In applying the results of these experiments to man, and in using them as contributory evidence in favour of the vascular theory of retinitis pigmentosa further reservations must be made. There is an important difference between the choroidal circulation in the rabbit and that in man. In the former the posterior ciliary arteries are functional end arteries and have no intimate connection with the anterior ciliary arteries as is the case in man (Studer 1906). This accounts for the fact that the areas of degeneration occur in the region of the equator, that is, immediately over the terminal arborization of the posterior ciliary arteries. In man they probably would have no such localisation. Studer's (1906) case, in which the posterior ciliary arteries, some of the anterior ciliaries and the optic nerve were cut in a patient with a painful glaucomatous eye, indicates that in man some of the anterior ciliaries must be cut also in order to produce retinal degeneration. In this case the area of degeneration extended right up to the ora serrata, and was confined to the side on which the anterior ciliary arteries had been cut, as a result of section of the external rectus muscle made in order to procure a good exposure. In the present series of experiments the area of degeneration bore no such relation to the muscle cut. If then at least two-thirds of all the posterior ciliary arteries must be cut to produce an area of retinal degeneration in the rabbit, it is apparent that a great many more would have to be cut in man, where the collateral circulation is better, in order to produce a similar lesion. Such vascular abnormalities as have been described in the choroid in cases of *retinitis pigmentosa would not have an effect even vaguely* approaching such changes.

Mention must be made also of the ophthalmoscopic changes produced by section of the posterior ciliary arteries. At no time *or place do they ever have the least similarity to those found in* retinitis pigmentosa.

TABLE I

DISTANCE FROM ORA SERRATA	TEMPORAL SIDE (degenerated)		PER CENT. OF NORMAL		NASAL SIDE (normal)	
	Rods	Cones	Rods	Cones	Rods	Cones
1	60	4	75	100	80	4
2	80	5	89	125	90	4
3	126	6	121	120	104	5
4	120	7	114	140	105	5
5	125	6	104	86	120	7
6	120	7	100	140	120	5
7	110	6	91	86	120	7
8	112	5	81	83	138	6
9	140	9	108	150	130	6
10	154	9	112	150	138	6
11	121	7	84	88	143	8
12	118	7	81	117	145	6
13	115	5	82	83	140	6
14	126	6	89	120	142	5
15	126	6	93	120	135	5
16	115	7	85	100	135	7
17	110	5	87	83	126	6
18	115	6	85	75	136	8
19	129	6	95	75	136	8
20	120	5	80	63	150	8
21	100	4	74	50	135	8
22	53	2	41	25	128	8
23	48	2	35	29	136	7
24	12	0	9	0	135	5
25	52	1	36	17	143	6
26	68	2	48	50	143	4
27	78	2	58	67	135	3
28	67	2	48	40	140	5
29	60	2	44	40	136	5
30	63	2	48	50	132	4
31	83	3	66	50	126	6
32	80	3	62	43	130	7
33	55	2	46	40	120	5

TABLE I—*continued*

DISTANCE *FROM* ORA SERRATA	TEMPORAL SIDE (degenerated)		PER CENT. OF NORMAL		NASAL SIDE (normal)	
	Rods	Cones	Rods	Cones	Rods	Cones
34	*60*	*2*	*43*	*34*	*140*	*6*
35	—	—	—	—	132	7
36	—	—	—	—	140	6
37	—	—	—	—	*140*	*7*
38	—	—	—	—	135	6
39	—	—	—	—	*138*	*7*
40	—	—	—	—	160	6
41	—	—	—	—	178	6
42	—	—	—	—	*192*	*6*
43	—	—	—	—	190	7
44	—	—	—	—	198	6
45	—	—	—	—	165	7
46	—	—	—	—	195	7
47	—	—	—	—	*178*	*8*
48	—	—	—	—	204	8
49	*75*	*3*	*38*	*37*	200	8
50	*150*	*7*	*61*	*100*	195	7
51	155	7	89	88	175	8
52	203	10	105	143	195	7
53	158	8	84	100	189	8
54	165	8	85	80	195	10
55	170	9	85	113	*200*	*8*
56	185	9	95	90	195	10
57	195	9	106	100	184	9
58	180	9	89	113	190	8
59	210	10	112	125	178	8
60	184	8	78	80	225	10
61	190	9	79	82	240	11
62	213	10	86	99	248	11
63	234	11	101	100	230	11
64	243	11	108	93	224	12
65	260	12	105	100	248	12

N.B.—Distance from the ora serrata is measured in oil immersion fields. One field equals 0·175 mm. Numbers in *italics* indicate area of degeneration.

The histological changes produced confirm absolutely those found by Wagenmann. The essential change is a massive degeneration of the retina, starting with the deeper layers and progressing through the retina to the surface. Superficially the degeneration starting with the rods and cones is similar to that found in retinitis pigmentosa. But here the similarity ends. Although the whole picture is unlike that of retinitis pigmentosa, it is true that the appearance of certain areas, particularly in the border regions can be picked out as very like the picture in that condition. A closer examination of the histological details, however, shows their all important differences. There is, for instance, much less gliosis and fibrosis in the present lesion than in retinitis pigmentosa, as, indeed, one might expect in a lesion that is so much more rapid in its progress. Pigment distribution also is entirely different. It remains in the deeper layers of the retina unless there has been complete destruction of all retinal layers, and at no time has it any relationship to the vessels of the retina.

Bourne, Campbell and Tansley (1938) have described a form of familial degeneration of the retina in rats, the histological features of which are indistinguishable from those of retinitis pigmentosa. In this condition the rods degenerate first, to be followed only some time later by the cones. The first signs of degeneration in these cells are to be found in the nuclei, a characteristic which does not seem to have been previously noted in retinitis pigmentosa, possibly owing to the lack of eyes in the earlier stages of disease, available for histological examination. If this condition in rats is really a form of retinitis pigmentosa it suggests that these cells die as a consequence of some disturbance of their intracellular metabolism. In the experimental lesion in rabbits the first signs of degeneration are not in the nuclei but in the outer limbs, probably because the nutrition of the cells is disturbed by external influences. The final difference between these two conditions is by far the most important. In retinitis pigmentosa the rods degenerate first, to be followed later by the cones (Stock 1908, Leber 1915, Collins 1919, Verhoeff 1931). In the experimental lesion in rabbits both degenerate equally rapidly.

In conclusion, it may be said that the present findings confirm in all essentials those found by Wagenmann in 1890. A re-evaluation of these results shows that they do not support the vascular theory of retinitis pigmentosa. On the contrary, there is much evidence against this theory. To account for some of the features of that disease one must assume some selective difference between the vitality of the rods and that of the cones.

Summary

1. Wagenmann's experiments, in which he produced a pigmented degeneration of the retina in rabbits by section of the posterior ciliary arteries have been repeated and confirmed.

2. It has been shown that it is impossible to interfere with the ciliary arteries without injuring the ciliary nerves, but it would seem that one is justified in assuming that the lesions thus produced are the result of a purely vascular disturbance.

3. It was found impossible to confirm Wagenmann's statement that section of only a few posterior ciliary arteries was necessary to produce these degenerative retinal lesions. Section of at least two thirds of all the arteries was necessary.

4. The ophthalmoscopic findings following operation were first, an ischaemia of the retina and choroid in the region supplied by the bulk of the vessels cut. This was followed by oedema, and then retinal degeneration in the areas where the circulation had not been restored. The pigment formed conglomerate masses and had no relation to the vessels.

5. Histologically the areas of degeneration showed massive necrosis of all retinal layers starting with the outer layers. At the borders of the regions stages in the process could be seen.

6. The choroid beneath these areas showed for the most part dilated vessels containing blood.

7. The histological appearances taken all together were unlike those of retinitis pigmentosa. Certain areas had a superficial similarity. Detailed examination of the latter showed that there was less gliosis, and a different pigment distribution from what occurs in retinitis pigmentosa. Degeneration of the rods and cones affected their nuclei last of all, and they degenerated equally rapidly.

8. It is concluded that the results of these experiments do not support the vascular theory of the causation of retinitis pigmentosa. On the contrary, evidence was found which is against that theory.

My thanks are due to the Medical Research Council for a grant that made this work possible. I am also greatly indebted to Dr. Katharine Tansley and Dr. R. J. Lythgoe for their invaluable advice and encouragement.

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ANNOTATION

National Ophthalmic Treatment Board

The Annual Report of the National Ophthalmic Treatment Board 1937-38 is now to hand. As in previous reports the work of the Board is dealt with under three main headings, viz., Investigation, Education and Administration of the National Eye Service.

With regard to the incidence of pathological conditions in cases of eye defect an analysis has been made last year of a fourth series of 10,000 cases. In each of these four series the returns have been collated by the same competent statistician, and the record cards upon which the returns have been made have remained unchanged. There has been no selection of cases.

The results are arranged in two tables. These should be studied by everyone concerned but it will be of interest if we give a transcript of Table I. "Cases of error of refraction only (1934) 64·09 per cent., (1935) 64·22 per cent., (1936) 63·59 per cent., (1937) 62·54 per cent.

Cases of error of refraction plus one or more other eye conditions (1934) 29·15 per cent., (1935) 27·88 per cent., (1936) 25·83 per cent., (1937) 28·03 per cent.

Cases without error of refraction, but with one or more 'other

eye conditions' (1934) 5·75 per cent., (1935) 7·36 per cent., (1936) 7·93 per cent., (1937) 8·69 per cent.

Cases with no appreciable eye defect (1934) 1·0 per cent., (1935) 0·54 per cent., (1936) 0·85 per cent., (1937) 0·75 per cent."

Table 2 gives the details and percentages of such conditions as are likely to appear in any eye examination.

The percentage figures vary only within very narrow limits as a general rule. In dealing with education it is of interest to note that increasing use is being made of propaganda by means of films.

The importance of the work undertaken by the National Ophthalmic Treatment Board can hardly be over emphasised. Its progress may appear to some to be slow but we feel certain that it is sure, and that in the long run it will lead to what is so earnestly desired, the ophthalmic services of the country being under the care of properly qualified ophthalmic practitioners.

ABSTRACTS

MISCELLANEOUS

(1) **Penman, G. G. and Wolff, E. (London).—Primary tumours of the lacrimal sac.** *Lancet*, p. 1325, June 11, 1938.

(1) **Penman** and **Wolff** review the literature of primary neoplasms of the lacrimal sac and comment on their rarity. It seems that carcinoma and sarcoma are the commonest, for out of 64 collected cases there were 24 of the former and 20 of the latter.

They describe a case of epithelial hyperplasia of the lacrimal sac in a man aged 75 years. Histological examination showed that the epithelial cells lining the sac had proliferated and formed many layers and that some metamorphosis from columnar cells to polyhedral cells had occurred. The basement membrane was intact but the authors consider that the neoplasm was on the borderline of malignancy. The lacrimal sac was excised and at operation it was found that the neoplasm and sac had eroded the lacrimal fossa. The bone and nasal mucosa at the site of the lacrimal fossa were removed and the cavity drained into the nose.

In this case it was thought inadvisable to give either X-ray or radium after operation. One year after operation there was no evidence of recurrence.

Neoplasms of the lacrimal sac cause epiphora and some inflammatory changes in the sac wall. The presence of a mucocele and patency of the naso-lacrymal duct renders the swelling partly reducible on pressure.

H. B. STALLARD.

(2) **Motolese (Florence).—Traumatic ruptures of the sclera. (Le rotture traumatische della sclera).** *Boll. d'Ocul.*, October, 1937.

(2) Rupture of the sclerotic is not a common accident; it may be either direct or indirect. **Motolese** has sought the cases of indirect rupture seen in the clinics at Florence and finds 23 among 150,000 patients seen. He gives a short history of each of these and discusses the treatment. A considerable proportion of the ruptures is found to have the conjunctiva intact over the scleral gap; in this case no interference should be undertaken. When the conjunctiva also is ruptured the parts between the lips of the wound must be replaced or removed, and the edges brought together by sutures passed from within outwards through the sclera or episclera, and the conjunctiva drawn over and sutured separately.

Indirect rupture is generally situated in the upper part of the sclera and is concentric with the limbus at about 2 mm. from it; it is produced by a hard blow from a blunt body. In the author's cases many were due to a blow from a cow's horn. In four only of the total number was useful vision saved. One man had suffered from rupture of both eyes at different times and in both the conjunctiva was intact; both eyes retained useful vision; in the two other cases the conjunctiva also ruptured.

HAROLD GRIMSDALE.

(3) **Cardello (Turin).—Irido-cyclitis with high tension. (Sull-Irido-ciclite ipertensiva).** *Rass. Ital. d'Ottal.*, November, December, 1937.

(3) Certain cases of iridocyclitis are met with in which the most marked symptom is the raised intra-ocular pressure; **Cardello** discusses the question why this is so. In some cases no doubt primary glaucoma has been diagnosed, when the real cause is irido-cyclitis, and precipitates may be found by careful examination; in such cases the anterior chamber is often shallow; it does not follow that all cases in which there are precipitates are not glaucoma, but high tension with a deep anterior chamber can be nothing but iridocyclitis. In the seven cases which are recorded here, the author has tried to find some general cause for the condition; in one only has he found no general disturbance, which, at least, might have bearing on it. He thinks that study of these cases may help to explain the mechanism of glaucoma: it seems clear that in some an alteration of the composition of the intra-ocular fluids is the chief cause; this may point to some degeneration of the vessels of the eye. He lays stress on the importance of mydriatics in the treatment of these cases.

HAROLD GRIMSDALE.

(4) **Heinsius, E. (Berlin).—Fundus changes in diabetics. (Ueber die Augenhintergrundsveränderungen des Diabetikers).** *Klin. Monatsbl. f. Augenheilk.*, Vol. C, p. 207, 1938.

(4) **Heinsius** investigated 221 cases of diabetes and found 45 cases of true diabetic retinitis. It occurred mostly with a blood sugar between 150-350 mgm. and in 50 per cent. of cases was accompanied by a low blood pressure. It was twice as frequent in women as in men. The author considers that neither arteriosclerosis nor hyperglycaemia is a primary factor in the onset of retinitis diabetica.

D. R. CAMPBELL.

(5) **Bencini (Siena).—Essential shrinking of the conjunctiva. (Raggrinzamento "essenziale" della congiuntiva).** *Boll. d'Ocul.*, May, 1938.

(5) **Bencini** gives the history of two cases of this rare disease. In the first, the condition had been in course of development for fifteen years. It had begun with what was thought to be catarrhal conjunctivitis with inturned lashes.

The discomfort had been relieved temporarily but had soon returned; gradually there had come on difficulty in moving the eyes and vision had failed. The patient had never noticed bullae on the skin or lips. The lower cul-de-sac of the right eye was almost completely obliterated; the eye was dry and the corneal epithelium in the periphery resembled skin; there were pterygia on both sides. The left showed similar changes but less marked. Vision in this eye was 5/10. Unfortunately before complete examination could be made, the patient developed bronchopneumonia and died.

The second patient, who had suffered from facial eczema since boyhood, was seen first in 1933 and again five years later. On the first occasion it was noted that the eyes seemed dry, and the conjunctiva of the lower lid thickened and attached to the caruncle. On the last visit the eyes seemed more dry and uncomfortable. The caruncles were more xerotic and retracted, and the adhesions between them and the tarsal conjunctiva, more extensive. Fragments of the conjunctiva, of the skin of the face, and of the mucous membrane of the lip were removed and examined.

Both the buccal mucous membrane and the conjunctiva showed marked increase of the epithelium; this produced in the eye, the appearance of vesicles in the section. The subconjunctival tissue was thickened but showed little sign of inflammatory processes. A full discussion of previous recorded cases is given.

HAROLD GRIMSDALE.

(6) **Orzalesi (Florence).—A case of retrobulbar neuritis of obscure origin in the course of psoriasis. (Neurite ottica a sede prevalentemente retro-bulbare e ad eziologia oscura nel corso di une psoriasi).** *Boll. d'Ocul.*, May, 1938.

(6) **Orzalesi** gives the history of a man who had been subject to recurrent attacks of psoriasis for some five years. He had been treated by many physicians and had received temporary relief. At the time when he came under the author's notice, the skin condition was quiescent. In January, 1938, the man noticed a rapid diminution of sight. The acuity was much reduced but the visual field was normal in extent; it showed a central scotoma of about 5° diameter. He had no pain, headache or vomiting. Ophthalmoscopic examination showed slight blurring and swelling of the discs; and one or two small haemorrhages into the retina near the discs. The small vessels were more visible than usual. The changes were less marked in the left eye. After about three weeks the ocular conditions improved, without treatment. The man, whose skin condition had sometimes worsened under medication, refused even to be examined unless he were allowed to remain without treatment. The vision in the right eye remained stationary; in the left, there was some improvement from 2/30 to 5/40. The scotoma became less dense but remained relative. There was no further change in vision so long as the man was under observation, but the discs became less blurred and all signs of neuritis disappeared. The author discusses the cause of the attack. None of the usual causes was to be found; there was no focus of sepsis, dental or tonsillar, no affection of the nasal sinuses found after repeated radiological examination, which further did not suggest changes in the chiasmal relations; there was no history suggesting toxic agency; finally the author discusses the possibility of disseminated sclerosis in which it may be a premonitary symptom; he thinks that it may be excluded in this case because the two eyes were attacked simultaneously and recovery was very incomplete. Had the psoriasis any causal relation, or was it merely a coincidental malady? The author thinks that since all other causes are found unlikely, there may have been some connection between the skin disease and the neuritis.

HAROLD GRIMSDALE.

(7) **Stengel, Alfred, jun. (Philadelphia).—Uveoparotitis.** *Annals of Surgery*, June, 1938.

(7) **Stengel** here records a case of uveo-parotid fever in a coloured male patient of 32 years of age. The illness began with indefinite symptoms of malaise in October, 1936. By November 24, earache had developed and a swelling in the left parotid region. Eye symptoms, he felt as if "there was an orange glass in front of

the left eye," were noted at the end of November, and by mid-December he was rather acutely ill with slight fever, and swellings over each parotid region, and on December 17 right facial paralysis was noted. This was of the peripheral type and was complete. Attempts to pass a catheter into Stenson's ducts failed. Posterior synechiae and corneal opacities in the left eye were noted on December 14. The fundus was not seen. The condition cleared up slowly, and on January 21, 1937, the swellings were much less, though traces of the right facial palsy remained. The paper is illustrated by photos of the patient on admission, and on January 21. The laboratory findings are fully described and the ophthalmologist's and aurist's reports are appended.

The aetiology is unknown but evidence in favour of tuberculosis has been reported by previous observers. In this case tuberculin tests were negative, and there were possible sources of infection in the teeth and tonsils and possibly in the sinuses.

R.R.J.

(8) **Sautter, H. (Tübingen).—Observations on the inflammatory pseudo-tumours of the orbit, with two cases of unilateral exophthalmos. (Beitrag zum Kapital der entzündlichen Pseudotumoren der Orbita an Hand zweier Fälle von einseitigen Exophthalmus).** *Klin. Monatsbl. f. Augenheilk.*, Vol. C, p. 29, 1938.

(8) **Sautter** describes two cases of inflammatory pseudo-tumour of the orbit in healthy subjects, in one of which there was a recurrence after removal. The section showed fatty tissue infiltrated with broad strands of connective tissue containing leucocytes and lymphocytes. There were numerous vessels, and in the second case areas of muscle tissue. The histological appearance agrees with Birch-Hirschfeld's description of such tumours. There was no evidence of any kind of infection.

D. R. CAMPBELL.

(9) **Rubino (Padua).—Optico-chiasmal arachnoiditis. (Contributo allo studio dell'aracnoidite ottico-chiasmatica).** *Riv. Oto.-Neuro.-Oftal.*, November-December, 1937.

(9) Modern studies of the arachnoid tend to show that it cannot undergo inflammation without involvement of the pia mater, more especially as the arachnoid is devoid of vessels.

Certain authors have suggested the term "leptomeningitis" for this condition but it has not been generally adopted. **Rubino** gives notes of five cases in which this condition was diagnosed. The ocular symptoms are of special importance in diagnosis, and especially the visual fields, which often resemble those caused by

tumours in the neighbourhood of the chiasma, but radiological examination of the skull will usually enable the surgeon to determine whether there is a tumour. On the other hand, a diffuse meningitis will give rise to general symptoms as well as local; in some cases the history of an injury immediately before the onset of the symptoms will assist in diagnosis.

In two of the five cases, treatment by iodides brought about considerable improvement; in the third case, in which there was a central scotoma, things remained stationary or nearly so. In the fourth and fifth cases the chiasma was freed by operation from the constricting bands and partial recovery followed. Both these patients had shown a central scotoma which became less dense after operation, but the field did not enlarge to full limits.

The author draws attention to the various ways in which the fields may be affected; the commonest defect is more or less regular concentric contraction; this suggests a lesion surrounding the chiasma and damaging the peripheral fibres of the nerves.

Next in frequency is temporal hemianopsia, often with a symmetrical central scotoma; hemiachromatopsia has never been observed in these cases, though it is a common symptom in the early stages of compression by tumour. Other forms of campimetric defect are less frequent.

HAROLD GRIMSDALE.

(10) **Clivio (Milan).—Optic atrophy following arachnoiditis; operation. (Su un caso operato di aracnoidite con atrofia degli ottici).** *Riv. Oto.-Neuro.-Oftal.*, March-April, 1938.

(10) **Clivio** gives the history of a child aged nine years, who had gradually become blind, with headache and vomiting. A radiogram showed calcification above the sella turcica. Ophthalmoscopic examination showed optic atrophy suggesting previous papilloedema. From the history Clivio diagnosed the probable cause of the illness to be arachnoiditis with the formation of cysts in the region of the chiasma.

An operation was undertaken; the frontal lobe lifted, and the adhesions round the chiasma and optic nerves cleared away; the hemispheres were found to be firmly bound together by adhesions and these were also freed.

As a result of this, some slight amount of sight was restored; the child, who had been completely blind, regained perception of light; since light perception had been lost for eight months before, more could hardly be expected. The author lays stress on the necessity for early and accurate diagnosis; if operation is to be undertaken with hope of restoration of sight.

HAROLD GRIMSDALE.

BOOK NOTICES

Diseases of the Eye. By SIR JOHN HERBERT PARSONS. Ninth Edition. *Pp. 658, 21 Plates* and 360 Text Figures. London: J. and A. Churchill, Ltd. 1938.

The ninth edition of this admirable text-book is a worthy successor to those which preceded it. Although "statistics can be made to prove anything," the fact that the last two editions have been exhausted each within two years, whereas previously the interval between succeeding editions was usually more than double this period, shows that there is an increasing demand for "Diseases of the Eye." One reason why this is not surprising, is that the first edition was published in 1907 so that the present contents represent so to speak, a process of natural selection operating on the facts and theories of ophthalmology for a period of over 30 years. Anything which has survived this process must surely be of the "*fittest*" and therefore worth reading.

The present edition differs only slightly from the last, mainly by incorporating some details as to new drugs and methods of treatment. In discussing vitreous haemorrhages for example, mention is made of vitamin C and the importance of this same vitamin in the metabolism of the lens is described.

The form of the book remains unaltered and the author has wisely refrained from increasing its bulk; once more we should like to extend our thanks and hearty congratulations to him.

Transactions of the Ophthalmological Society of the United Kingdom. Vol. LVIII, Part 1. London: J. and A. Churchill, Ltd. 1938.

The first part of the *Transactions* for the current year contains the proceedings of the annual congress held in April together with the transactions of the North of England and South Western Ophthalmological Societies. The secretaries are to be congratulated on the early date of its appearance and the volume itself is of more than usual interest. The discussion on the causes of exophthalmos is reported in full and there is a wealth of interesting material, among which von Rohr's lectures to the North of England Ophthalmological Society on the general history of spectacles are particularly worthy of note.

The general state of the society and its financial position are both satisfactory in spite of the extra cost involved in publication in two volumes. This extra cost amounts to about £85. We hope that in future this figure will be reduced.

Northern Counties Association for the Blind.

The thirty-second annual report 1937-1938 forms an octavo pamphlet of 80 pages. The association covers an immense area comprising the six northern counties of England. The tables on pages 68-69 are of great interest. They deal with the classification as to the causation of blindness according to sections of forms B. D. 8 and 37 D. That on page 68 shows the total percentages while that on the following page shows the sub-classification according to sub-sections of the forms already mentioned. These sub-sections are *A*, Congenital and undetermined causes. *B*, Infections and bacterial. *C*, Traumatic and chemical. *D*, General diseases. *E*, No information obtainable. Taking a few totals from this table we note that myopic error accounted for 853 cases; primary glaucoma, 1,005; primary cataract, 3,356; intra-ocular tumour, 18; ophthalmia neonatorum, 405; trachoma, 33; industrial trauma, 247; industrial disease, 15; non-industrial trauma, 206; birth trauma, 8; sympathetic ophthalmitis, 4; vascular disease, 299; diabetes, 215.

Copies of the posters issued by the National Safety First Association (inc.) in conjunction with the Industrial Welfare Society (inc.) are annexed to the report. C1/P/M16 shows a portrait of Robert Burns, whose name figures on the right hand side of the picture: beneath it the sentence "so does acid" is underlined and "wear your goggles" appears in large capitals at the bottom. "To what base uses may we return?" might have been the ejaculation of Robert Burns had he been alive to see it, but if only a single eye is saved by this form of propaganda we feel sure that he would have applauded the use of his name. After all Shakespeare in an earlier age introduced the idea of Imperial Caesar's remains as stuffing for a hole; so Burns is in good company.

CORRESPONDENCE

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—Having recently returned from a tour of American Eye Hospitals I thought it might interest your readers to hear something of the work that is being done over there.

I arrived in America at the beginning of June, but I would like to point out that this is not an ideal time of year for such a visit. First because it is the beginning of the hot season, and secondly because a number of surgeons take their summer holidays at this

time of the year. Both the late Dr. Wheeler, of New York, and Dr. Verhoeff, of Boston, were away, so that I was denied the privilege of seeing their work.

The Hospitals I visited were:—The New Haven Hospital; the Eye and Ear Department of the Massachussetts General Hospital, Boston; the New York Hospital; the New York Eye and Ear Hospital; the Manhattan Eye and Ear Hospital; the Knapp Memorial Hospital and the Presbyterian Hospital, both in New York; the Wills Hospital and the Pennsylvania University Graduate Hospital, both in Philadelphia; the Wilmer Institute of the Johns Hopkins Hospital, Baltimore. The Out-patient departments as a whole deal with a much smaller volume of patients, and have a comparatively larger number of assistants than the London Eye Hospitals. Most of them have an appointment system for refractions. They are thus able to investigate much more fully each individual case. They also have a relatively larger number of Residents, so that although the Residents assist in the Out-patient departments, they have sufficient time to carry out some research work. The New York Eye and Ear has ten residents for about 120 beds, and the Wills Hospital in Philadelphia has eight for about 140 beds. Most of these Hospitals are recently built, and are very well laid out and equipped, including air conditioned operating theatres, and loud speaker system for calling the residents. The wards are spacious and airy, though at this time of year only about three-quarters full. The nurses' and residents' quarters are comfortable, and in places almost luxurious. The trained nurses earn about £140 per year, but the residents, except for one or two places in New York, are paid nothing at all, nor do they receive any of the usual house surgeons' perquisites.

As regards the operative work:—

Cataracts.—In most Hospitals intracapsular extractions are attempted in all suitable cases, usually with complete iridectomy, and using either Arruga's or Verhoeff's forceps. The New York Eye and Ear, and the Wills Hospital are the chief exceptions, and here a large number of combined extractions and extractions after preliminary iridectomy are done.

Squints.—Chiefly done by resection and recession. Advancement is rare and free tenotomy almost unknown.

Glaucoma.—The Elliot trephine is still the most popular operation, but quite a number of surgeons are in favour of iridencleisis. I heard of one case of sympathetic ophthalmitis following the latter. Cyclodialysis does not seem to be very popular.

Detached retina.—Diathermy by the Safar-Walker technique is being used almost exclusively. I was very surprised to find that in a number of Hospitals they were finding retinal tears in less than half the cases. It is possible that the wide use of the May type of

ophthalmoscope is responsible for this. The percentage of successful results was low in most places.

I cannot speak too highly of the kindness, hospitality, and courtesy which I encountered everywhere I went, and which made my visit so very enjoyable.

Yours, etc.,

EDWARD C. ZORAB.

SOUTHAMPTON, 1938.

TRIAL FRAME SPIRIT LEVEL

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—With regard to the trial frame spirit level device, Mr. McKie Reid obviously has priority by several years.

The device, which I first produced in 1935, was shown at the Oxford Congress (or rather the B.M.A. meeting which replaced it) and was shown subsequently at the North of England Ophthalmological Society—on whose agenda it appears in December, 1936.

I am afraid some of our mutual colleagues must be a little unobservant, as Mr. McKie Reid's letter is the first intimation I have had that anybody had produced a similar device.

I am glad to find that someone else has found the necessity for such an arrangement, as there quite a few cases in my opinion, in which it is necessary to use it.

Yours faithfully,

JOHN FOSTER.

45, PARK SQUARE, LEEDS, 1.
October 11, 1938.

OBITUARY

G. E. de SCHWEINITZ

It is with great regret that we record the death of Dr. George Edmund de Schweinitz on August 22, 1938.

De Schweinitz was born in October, 1858, the son of Bishop Edmund de Schweinitz, of the Moravian Church, Bethlehem. He was educated at Bethlehem Moravian College and at the University of Pennsylvania Medical School, graduating in 1881. As an

ophthalmologist de Schweinitz won international fame. He had been professor of ophthalmology at Jefferson Medical College and in the University of Pennsylvania. At various times he was President of the American Medical Association, the American Ophthalmological Society, the Academy of Natural Sciences and the American Philosophical Society. His well known text-book has passed through many editions and is popular in this country as well as in the United States. In 1930 he was awarded the Leslie Dana Medal for his work on prevention of blindness. In 1923 he delivered the Bowman Lecture before the Ophthalmological Society of the United Kingdom, its title was, "Concerning certain ocular aspects of the pituitary body disorders, mainly exclusive of the usual central and peripheral hemianopic field defects," 88 pages of the transactions are given to this noble effort. And since then he has been one of the small band of honorary members of the Society.

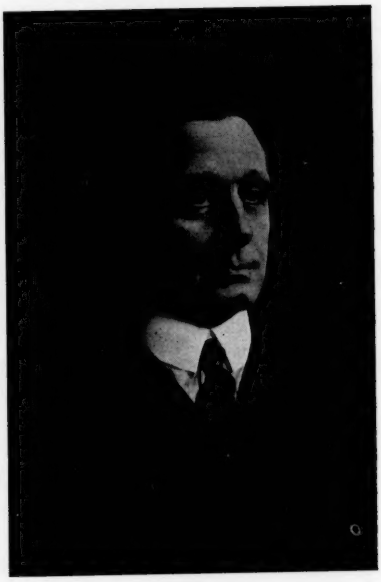
De Schweinitz served in France during the great war as Lieut.-Colonel in the American Medical Force. He retired from active practice about two years ago when his health began to fail.

We are indebted to the *Record* of August 23 for much of the information abstracted here.

A mere catalogue of de Schweinitz's attainments gives a quite inadequate idea of his personality and of his outstanding position, not only in the history of ophthalmology but also of medicine in the United States. He was not only a great surgeon but also a great physician, and it was eminently apt that he should have held the presidency of the Philadelphia College of Physicians. It is unnecessary to give chapter and verse in this Journal for his work in ophthalmic medicine and surgery. It is well-known to all. His life was unremittingly devoted to ophthalmology and to the encouragement of medicine in the famous and old established University of Pennsylvania. An object which he had much at heart was the enrichment of the magnificent medical library in Philadelphia, and much of the time of his annual visits to this country was devoted to seeking out medical incunabula in London and elsewhere. de Schweinitz belonged to the type of American which we associate with New England, but which also flourishes in Pennsylvania—that erudite and highly cultured type, whose distrust of humbug and anything cheap engenders a reserve which can be as impenetrable as armour-plate. Only those who succeeded in overcoming this reserve can appreciate the sterling worth which it masks. To his accepted friends de Schweinitz was a delightful companion and a staunch comrade. His fame in the history of American medicine is assured.

J. H. P.

DR. GEORGE EDMUND DE SCHWEINITZ



C. G. RUSS WOOD

L. DE BLASKOVICS

C. G. RUSS WOOD

We regret to announce the sudden death on September 26, at the age of 69, of Cyril George Russ Wood, O.B.E.

He was the only son of Mr. Cyril J. Wood of Bath.

His medical studies were pursued at Bristol University and he obtained his M.R.C.S., L.R.C.P. in 1892, and his F.R.C.S.(Eng.) in 1902. At first his main interests were devoted to the study of pathology but shortly afterwards he came under the inspiring influence of the late Mr. F. Richardson Cross, who turned his thoughts to ophthalmology and led to his appointments as Hon. Ophthalmic Surgeon to Southport Infirmary and Southport Eye, Ear and Throat Hospital. In 1900 he was appointed Hon. Surgeon to the Eye, Ear and Throat Hospital, Shrewsbury, and it is to his lasting credit that in the exceedingly full and busy life that followed he gained his Fellowship though amongst other difficulties it involved a visit twice weekly to Birmingham University for the study of practical anatomy.

His services to the Hospital in Shrewsbury were the means of raising its status to a very high level and his name soon became widely known and respected in Shropshire and Mid Wales, not only as an Ophthalmic Surgeon but also as an Oto-laryngologist. He added to his appointments those of Hon. Ophthalmic and Aural Surgeon to the Royal Salop Infirmary, the Shropshire Orthopaedic Hospital, Wrexham Infirmary, the Montgomery County Infirmary and Much Wenlock and Broseley Hospitals, to all of which he held the position of Hon. Consulting Ophthalmic Surgeon at the time of his death.

His association with the British Medical Association dates from 1892 and he was from 1900 to 1931 an active member of the Shropshire and Mid Wales branch, being elected President in 1925.

Since the institution of the Oxford Ophthalmological Congress in 1909, Mr. Russ Wood, as one of its founders, had always been one of its keenest and most active members. He was elected Hon. Secretary in 1928 and became Master in 1935. He served as President of the Midland Ophthalmological Society, being elected to deliver the Middlemore lecture in 1927, and he was also a member of the General Committee of this Journal, at whose meetings he was a most regular attendant until quite recently.

On his retirement from practice in Shrewsbury in 1931 he was elected Assistant Surgeon and Pathologist to the Oxford Eye Hospital and later Consulting Surgeon, while at the same time he became Lecturer in the Oxford Post-Graduate Course in Ophthalmology and Examiner in Ophthalmology to Queen's University, Belfast.

He had a very wide knowledge of the literature of his subject

and his contributions though comparatively few were essentially practical.

Outside his professional work he had many interests. In his earlier life he was a keen amateur actor, and a great walker, both in England and on the Continent. He was a reader and student of history; his conversation was always stimulating, revealing the wide range of his knowledge.

In 1898 he married Fanny Mein, daughter of Dr. Charles Steele of Clifton and had three daughters, for whom great sympathy will be felt in their bereavement. To his wife's support and devotion he freely acknowledged much of his success and from her death in 1935 he was never quite the same man again.

His personality attracted a wide circle of life-long friendships and his loss will be deplored by many.

L. de BLASKOVICS

With the death of Ladislas de Blaskovics medical science, the Hungarian nation, our University and suffering humanity in general have sustained an immense loss.

Born in 1869, he took his M.D. degree in 1893. For a period of ten years he was assistant at the University Eye Clinic of Budapest and for twenty years Director of the Royal Hungarian State Eye Hospital. In 1928 he was appointed Professor of Ophthalmology and Director of the second University Eye Hospital in Budapest. Since my own retirement in June, 1936, he was my successor in the oldest chair in ordinary of the world, and Director of the two united University Eye Hospitals of Budapest.

He was a surgeon born. As early as 1892, in his student days, he drew attention to himself by his technical skill in the operations he performed on animals. On my proposal he joined the staff of the University Eye Clinic, where the extensive material at his disposal gave him ample opportunity to develop his surgical gifts. Later the State Eye Hospital with its 170 beds opened the way to independent work. His career followed in all things the lines laid down by Sir William Osler as desirable for a University Professor: first *study*, then *research work*, then *instruction*, and finally a well-timed retirement.

His scientific work covered the entire domain of Ophthalmology and was characterised by extreme and conscientious thoroughness. He achieved lasting results in many and various fields; thus it was he who proposed a new unit for the measurement of the vision: "oxyoptry," which replaces the one-minute test for the angle of vision by that of one degree.

But his chief work remained operations on the eye. He discovered numerous new methods of which the best-known was that applied against ptosis and was recognised throughout the scientific world as a master of plastic surgery of the eyelids. His "Surgery of the Eye" went through several editions in Hungary; it was also published in German with the collaboration of Aladár Kreiker and is shortly to appear in an English edition.

As a man he was distinguished for his nobility of character, sincerity, honesty and sense of justice. He was patriotic, deeply religious, yet tolerant of other people's faith, tender with his patients and a true and faithful friend—a gentleman in the best sense of the world, who had not an enemy in the world. His work will be his best memorial.

EMILE DE GRÓSZ.

NOTES

Death

WE regret to announce the death of Dr. J. M. Wheeler, of New York, on August 22, 1938. We hope to publish a memoir in our next number.

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Appointments

MISS E. E. CASS has been appointed Hon. Ophthalmic Surgeon to the New Sussex Hospital for Women and Children, Brighton.

MR. JOSEPH MINTON has been elected Assistant Ophthalmic Surgeon to the West End Hospital for Nervous Diseases.

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The Treacher Collins Prize

THE Council of the Ophthalmological Society of the United Kingdom has instituted a prize of £100, awarded triennially, for the best essay submitted upon a subject selected by the Council. The prize is open to qualified medical practitioners of any nationality, and the essay is to be written in the English language. The subject for the first award is "Cerebro-spinal disease and its relation to the optic nerve."

The closing date for sending in essays for the first award is December 31, 1938, they should be sent to the Hon. Secretary, Ophthalmological Society of the United Kingdom, 5, Racquet Court, Fleet Street, London, E.C.4.

Ophthalmological Society of Australia

THE first annual meeting of the Society will be from April 3 to 6, 1939, at Melbourne. Ophthalmologists are cordially invited. Information may be obtained from the Hon. Secretary, Dr. Darcy Williams, 193, Macquarie Street, Sydney, N.S.W.

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North of England Ophthalmological Society

THE annual lectures under the aegis of the North of England Ophthalmological Society will be delivered at the Royal Eye Hospital, Manchester, by Professor H. E. Roaf, on Friday, January 20, and Saturday, January 21, 1939, at 4.30 p.m. and 11 a.m. respectively.

The title of the first lecture is "The relation of the Retinae to the Cerebral Cortex," that of the second, "Recognition of Colour."

Members of other ophthalmological societies are cordially invited to attend.

FUTURE ARRANGEMENTS

1938

November 11.—Section of Ophthalmology, Royal Society of Medicine.

November 18.—North of England Ophthalmological Society, at Bradford.

December 6.—Midland Ophthalmological Society (Middlemore Lecture), Birmingham and Midland Eye Hospital.

December 9.—Section of Ophthalmology, Royal Society of Medicine. (Clinical Meeting.)

December 16.—North of England Ophthalmological Society, at Leeds.

1939

January 13.—Section of Ophthalmology, Royal Society of Medicine.

January 20.—North of England Ophthalmological Society, Annual Lecture, at Manchester.

January 21.—North of England Ophthalmological Society, Annual Lecture, at Manchester.

February 3.—North of England Ophthalmological Society, at Newcastle-upon-Tyne.

February 3.—Midland Ophthalmological Society, at Oxford Eye Hospital.

February 10.—Section of Ophthalmology, Royal Society of Medicine.

March 3.—North of England Ophthalmological Society, at Liverpool.

March 10.—Section of Ophthalmology, Royal Society of Medicine. (Clinical Meeting.)

March 31.—North of England Ophthalmological Society, at Sheffield. (Joint Meeting with the Midland Ophthalmological Society.)

May 19.—Midland Ophthalmological Society, at Gloucester Royal Infirmary and Eye Institution.

June 9.—Section of Ophthalmology, Royal Society of Medicine. (Annual.)

October 6.—Midland Opthalmological Society, at Birmingham and Midland Eye Hospital. (Annual.)

CONTEMPORARY OPHTHALMIC LITERATURE

Archives of Ophthalmology. *August, 1938.*

BIELSCHOWSKY. *Disturbances of the vertical motor muscles of the eyes.*

SLOAN and WOODS. Perimetric studies in syphilitic optic neuropathies.

BIRGE. *Cancer of the eyelids, conjunctiva and cornea*; squamous cell epithelioma.

THYGESON. Treatment of staphylococcic conjunctivitis with staphylococcic toxoid.

THYGESON. Mannitol fermentation as an indicator of conjunctival pathogenicity of staphylococci.

PATON. Recurrent retinal and vitreous haemorrhages in the young—Eales' disease. Report of two cases.

EVANS. An ophthalmic carriage.

KRONENBERG. *Topography and frequency of complications of uveal sarcoma.*

KRAUSE. Inositol in the ocular tissues.

American Journal of Ophthalmology. *September, 1938.*

ESSER. Biological frontal flaps in ophthalmology.

EVANS and MCFARLAND. The effects of oxygen deprivation on the central visual field.

SCHWICHTENBERG. *The evaluation of orthoptic training for aviators.*

LEWIS. Inflammatory pseudotumour of the orbit.

FROST. *Chloroma.*

JACKSON. Applied mechanics of cataract extraction.

THYGESON. A papillary type of Beal's conjunctivitis.

TASSMAN. The use of paredrine in cycloplegia.

NITZ. An evaluation of visual-testing methods in schools.

Annales d'Oculistique. *September, 1938.*

REDSLOB. Contribution to the study of the genesis of retinal detachment.

VOS. Cataract of dystrophia myotonica.

STRAKHOW. Intracapsular cataract extraction. Its advantages and disadvantages.

CORNET. Cyclodialysis-sclerectomy. Anti-glaucomatous operations.

Zeitschrift für Augenheilkunde. *August, 1938.*

AUFFINGER. Attempts to solve the question of the implantation of a ball after the excision of an eye.

CUSTODIS. Anatomical examination and clinical observations on the syndrome of the disease of the pterygo-palatine fossa.

KREIBIG. Plastic reconstruction of the lids.

ALLMARAS. Observations on familial glaucoma.

Rassegna Italiana d'Ottalmologia. *May-June, 1938.*

GANDOLFI. Bilateral amaurosis from anatomical and functional alterations of the retinal circulation,

FARINA. Tuberculosis, syphilis and chronic anterior uveitis.

RUSSO. Action of "Veritol" on the eyes.

BAQUIS. Ocular complications in intestinal amebiasis.

COSSU. Acute conjunctivitis from micrococcus catarrhalis.

BORSELLO. Observations on the pathological anatomy of the trachomatous granules.

MATHIS. A case of leucosarcoma of the choroid.

Archivos de Oftalmologia de Buenos Aires. *June, 1938.*

WESKAMP. Uniocular diplopia.

DAMEL. Pre-retinal haemorrhage.

ORIBE and MALBRAN. Anatomical considerations on glioma retinae.

July, 1938.

PAVIA. Malignant melanosis of the ciliary body.

VON GROLMAN. Pseudo optic neuritis.

CARRILDO, MALBRAN and CHICHILNISKY. Barbituric retrobulbar neuritis. Intoxication from luminal

Revista Cubana de Oto-Neuro-Oftalmiatria.

March-April, 1938.

FINLAY. Treatment of incipient cataract by means of vitamin C.

AVALOS. Electric ophthalmia caused by industrial accidents.

MONTES and SILVA. Erythema nodosum and phlyctenular kerato-conjunctivitis in a tuberculous child.

MENDOZA. The oculist and accidents at work.